POWER

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Autumn

"The melancholy days have come, the saddest of the year."

BUT why? Autumn is the time of harvest, the season of fruition. If a man has sown wisely and cultivated diligently, if his fields are full and ripe and his barns well stored, why should his heart be sad?

Why should he reap the fruits of his industry in any other than a spirit of gladness and thanksgiving, of joy in the returns of a season of living and of labor?

True, there will be regrets. It is the time for the demonstration of failure as well as for the consummation of success.

There will be things that did not come through. There will be dreams indulged in in the springtime of promise that have not been realized. There will be intentions conceived in the winter evenings of preparation, strong in the virile days of lengthening sunshine, allowed to dwindle and die in the engrossments of the growing time.

Others may have done better. He could do better again. He may have had reverses and misfortunes but the falling leaves and coming snows will cover the records of his remissnesses and the winter into which he drifts full-handed need not be one of discontent.

"There is harmony
In Autumn and a luster in its sky,
Which thro' the summer is not heard
or seen."

F. R. Low

Canadian Newsprint Mill Has Unusual Steam Plant

Steam Accumulator Is Used with Electric Boilers

SINCE the first of the year Price Bros. & Co., Ltd., have been operating at their Riverbend (Quebec) newsprint mill, a boiler plant of unusual design. Steam generated by two 32,000-kw. electric boilers is supplied to process at two pressures kept constant by sensitive governor valves, regardless of the loads. A steam accumulator floating on the line between the two governor valves absorbs or delivers the difference between the steam passing the high-pressure valve and the demand for low-pressure process steam.

ONE of the first high-pressure steam accumulator plants to be installed on this side of the Atlantic is at the new newsprint mill erected by Price Bros. & Co., Ltd., at Riverbend, in the Province of Quebec. This mill was designed by George F. Hardy, consulting engineer. It contains three sulphite digesters and two paper machines capable of a daily production of 200 tons of newsprint and has been in operation since December, 1925. The entire mill is operated on hydro-electric power supplied by the large Price-Duke power development on the Saguenay River. This power is at present available at such a low price that it has been found economical to generate all steam from electricity. For this purpose two 32,000-kw. electrical steam generators are installed, one of which is kept in operation while the other serves as a stand-by. The arrangement of the steam plant is shown diagrammatically in Fig. 1.

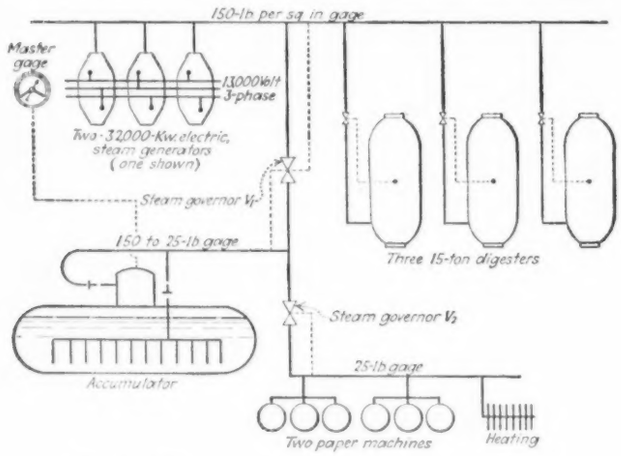


Fig. 1—Diagrammatic layout of steam system

Referring to this diagram, it will be seen that two different steam pressures are required. To the high-pressure steam system, in which 150 lb. is carried, are connected the electrical steam generators and the pulp digesters. The low-pressure system (25 lb.) supplies steam to the driers of the paper machines and also for heating the mill and other purposes. The two steam systems are connected with each other and with the accumulator by means of the two steam governors V_1 and V_2. These steam governors constitute, in this case, the entire automatic control of the accumulator system.

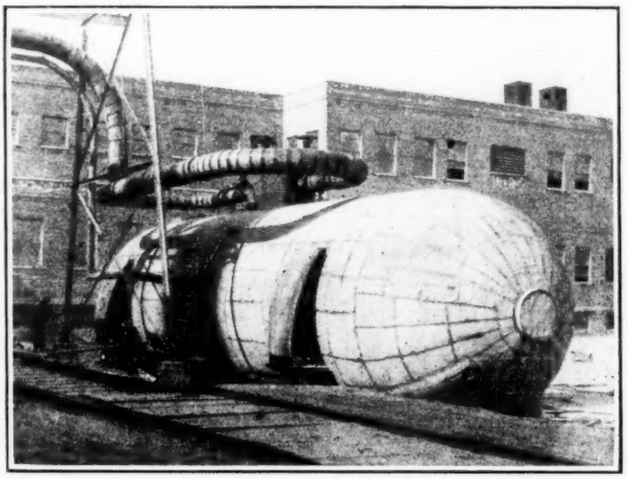


Fig. 2—The steam accumulator can absorb 40,000 lb. of steam in the pressure range from 25 lb. to 150 lb.

The operation of this system is as follows: The boiler plant may be run at a constant output, corresponding to the average steam consumption of the mill. The digesters will then take their part of the steam load directly from the high-pressure line. The entire excess of the boiler output over the demand of the digester house will be passed through steam governor V_1, which is controlled by the 150-lb. steam pressure.

Governor V_1 is set for a pressure slightly below the popping point of the safety valves on the boiler, so that waste of steam through the boiler safety valves is prevented at all times. The second steam governor V_2 is controlled by the low pressure, so that a constant pressure of 25 lb. is maintained in the low-pressure system.

If, now more steam is passed from the high-pressure system through governor V_1 than is required at the same moment in the low-pressure system, the excess will be passed to the accumulator, where it will be stored by heating up the water content of the accumulator. If, on the other hand, the steam flow through governor V_2 exceeds the supply of steam through governor V_1, pressure in the accumulator will drop and a sufficient quantity of boiling water will be flashed into

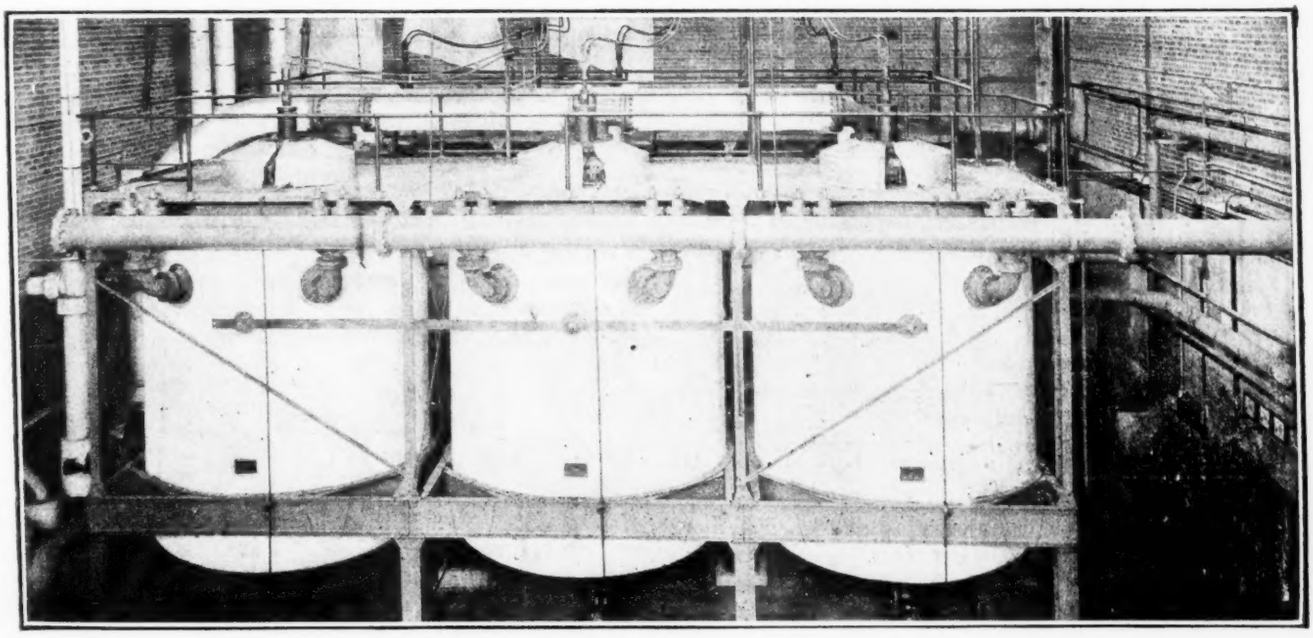
steam to make up the deficiency in the low-pressure system.

With this system fluctuations in the supply of steam from the steam generators, as well as fluctuations in the consumption of high-pressure or low-pressure steam, are automatically transmitted to and taken care of by the accumulator. Pressure fluctuations are strictly limited to the accumulator, constant pressures being maintained in the high- and low-pressure systems.

The steam generators may be operated at a constant rating as long as the accumulator pressure varies within normal limits. Only in case the accumulator pressure, which is indicated in the boiler house by an illuminated master gage, should approach its highest or lowest level, would the output of the steam generators have to be decreased or increased slightly. Such exceptional changes in the output of the steam generator may be effected gradually and slowly, because of the large storage capacity of the accumulator.

The accumulator renders the supply of energy and the demand for energy to a great extent independent of each other. This makes it possible to regulate the consumption of energy in the electrical steam generator in such a way that the total consumption of electrical energy, including that required for the various motors throughout the plant, may be maintained at a practically constant value. This is of great importance, due to the fact that the electrical energy is purchased on a maximum-demand basis, so that the elimination of peak loads by the accumulator results in reduced costs.

The electrical steam generators were designed and built by Dominion Engineering Works, Ltd., and are of the Kaelin three-tank type, each tank being connected to one phase of the three-phase circuit. There are two



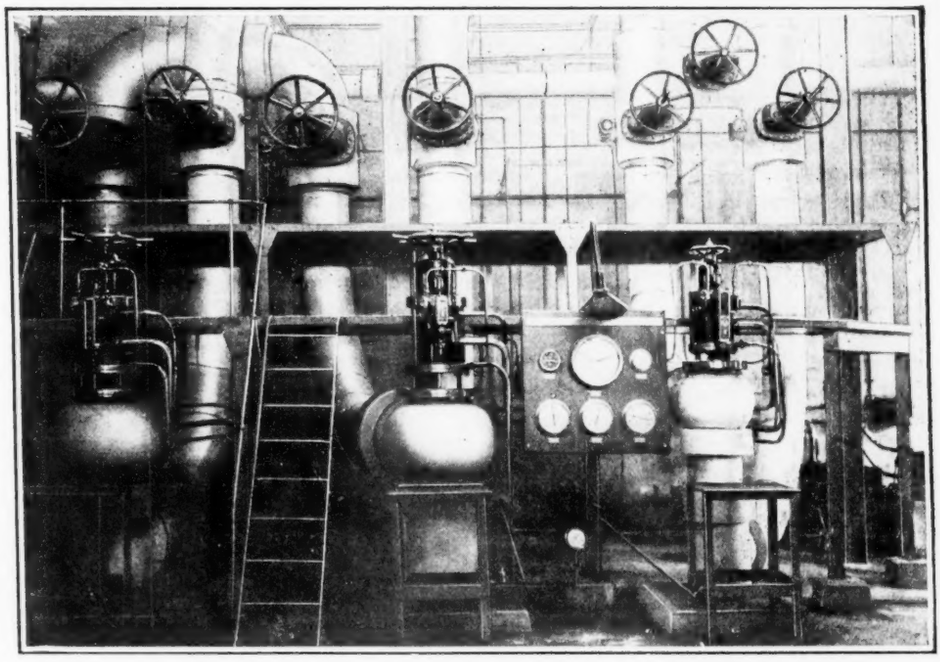


Fig. 3 — (Above) Steam is furnished by two 32,000-kw. electrical steam generators. The three tanks in the foreground constitute one generator (three-phase)

Fig. 4—(Right) Pressure governors. The governor on the right keeps the pressure constant in the high-pressure main. The other two hold the low pressure constant

units, each of 32,000-kw. normal capacity and capable of generating over 100,000 lb. of steam per hour. They are designed to operate at 13,200 volts and, both in capacity and actual size, are the largest electric steam generators built to date.

The tanks are 9 ft. 6 in. in diameter by 14 ft. 6 in.

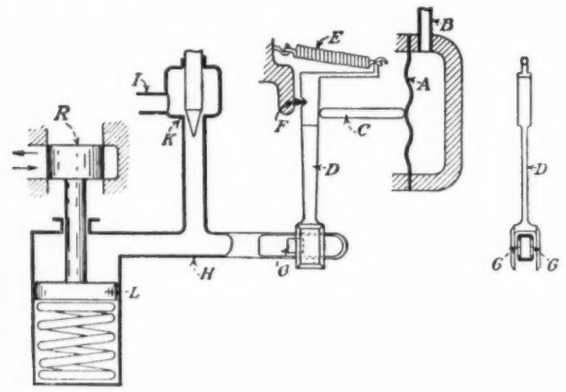


Fig. 5—Diagram showing principle of operation of pressure governor

Pressure acting through diaphragm *A*, connection *C* and lever *D* varies oil-waste opening at *G* and thereby produces motion of pilot piston *L*.

long and are mounted on a steel framework. The electrodes are of the multiple-rod type of conical design, thus providing a large area to reduce the current density on its surface and at the same time tending to prevent the accumulation of steam bubbles on the electrode with consequent arcing The protector or neutral plate is in easily removable sections and is heavily grounded independently of the shell.

Both generators are operated from a central control station, and all the water gages, feed valves, bleeder valves and ammeters are located at this point within easy view and reach of the operator. The total space occupied by one unit is approximately 34 ft. long, 11 ft. wide and 21 ft. high. Each generator is equipped with a battery of twelve 4-in. safety valves.

The accumulator, made by the Ruths Accumulator Co., has a diameter of 14 ft. and a length of 53 ft., corresponding to a total volume of 7,500 cu.ft. It has a storage capacity of 40,000 lb. of steam in a pressure range from 150 to 25 lb. The accumulator requires no building protection. Heat losses are negligible owing to the fact that the radiating exterior surface is comparatively small compared with the total volume of the accumulator, so that an insulation of 3 in. to 4 in. thickness is entirely sufficient. The accumulator is supported flexibly on four bearings which allow for free expansion under varying temperatures. As shown in Fig. 3, the accumulator is covered with insulation protected from the weather.

Fig. 4 shows what may be called, by electrical analogy, the "steam switchboard" for this installation. In the front may be seen three Ruths "steam governors." The governor at the right corresponds to that spoken of earlier as V_1, and the two governors to the left correspond to governor V_2. These designations were also used in Fig. 1. One of the latter is provided for stand-by use. Above these steam governors may be seen a number of stop valves which make it possible to isolate any part of the piping system. These are accessible from a common platform. The picture also shows the indicating and recording pressure gages.

A section through one of the governors is shown in Fig. 6. The valve proper is of the balanced type with two disks *M* which are actuated by a servomoter consisting of oil cylinder *O* and the spring-loaded piston *P*. The valve is operated by oil pressure supplied by a small gear pump. The supply and discharge of oil to and from the servomoter is controlled by pilot valve *R*.

The apparatus to the right of pilot valve *R* is called the relay and serves as the receiver for the pressure impulse from the steam line. In addition, it has the important function of magnifying the delicate impulse given by a very slight change in steam pressure so that it is able easily to actuate pilot valve *R*.

The principle of this relay may be understood from the diagram in Fig. 5, in which the different parts are designated by the same letters as in Fig. 6. The pressure is admitted through a small pressure pipe *B* to the steel diaphragm *A*. This diaphragm is of great strength and moves under actual operating conditions only a few ten-thousandths of an inch. This minute movement is transmitted by rod *C* to lever *D*, which is held against

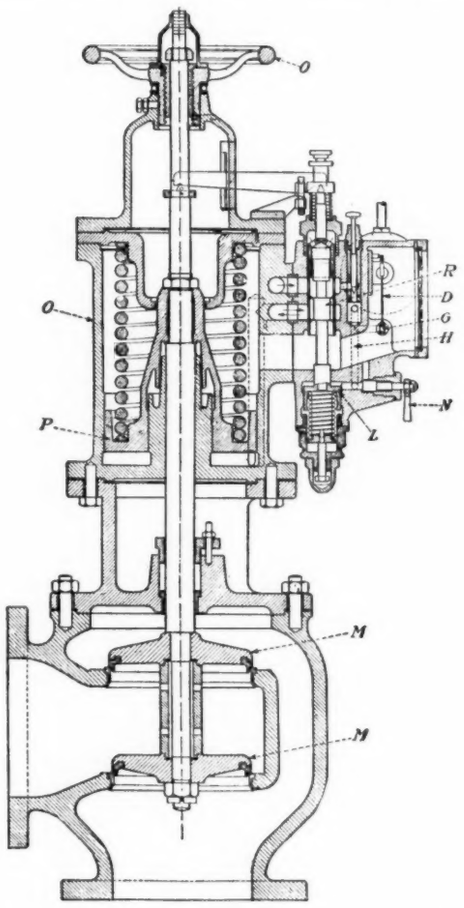


Fig. 6—Cross-section of pressure governor, showing actual construction

edge *F* by spring *E*. The lower fork-shaped end of this lever loosely covers two opposite orifices *G* in the oil pipe *H*. Oil is supplied at constant pressure through pipe *I* and is throttled at *K*. The movement of diaphragm *A* is magnified about fifty times by lever *D*, thus changing the size of the orifices *G*, and hence the pressure in pipe *H*, and resulting in a certain movement of the spring-loaded piston *L*. This piston is connected to pilot valve *R*, thus controlling the supply and dis-

charge of oil to the servometer and actuating the main valve.

In cases where several valves have to co-operate with one another or with steam turbine governors, it is important that the speed of regulation be adjustable within wide limits. Provision has therefore been made so that the time required for one full stroke can readily be adjusted from 60 seconds down to one-fifth of a second. The valves are further equipped with emergency trip lever N, the valve being closed instantaneously by a quarter turn of this lever.

The pressure charts shown in Fig. 7 were obtained a few months after this installation was started. They represent typical operating results as obtained continuously without special adjustment.

The three steam-pressure charts show the operation of the accumulator plant on Tuesday, May 4, Saturday, May 8, and Sunday, May 9. Charts for Monday, Wednesday, Thursday and Friday were similar to that shown for Tuesday. The pressure line at 150 lb. indicates the pressure in the high-pressure or boiler header. As can be seen, this pressure is maintained constant by the governor V_1. The pressure line at 30 lb. indicates the pressure in the low-pressure header leading to the paper machines. This pressure is maintained constant by the governor V_2. It will be noted that

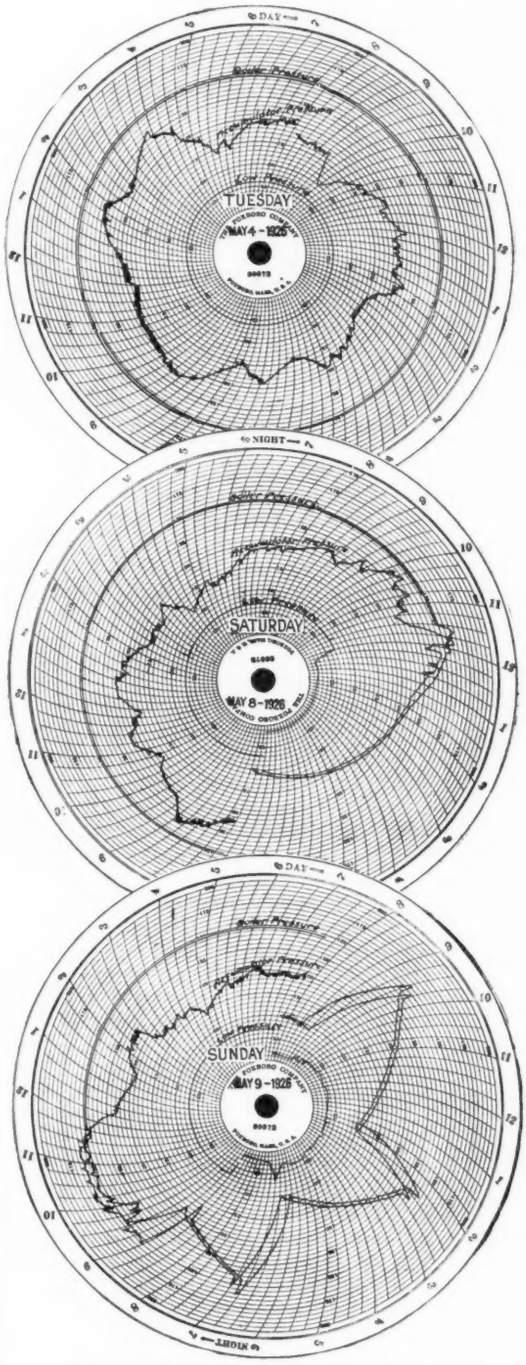


Fig. 7—Pressure charts for May 4, 8 and 9, 1926

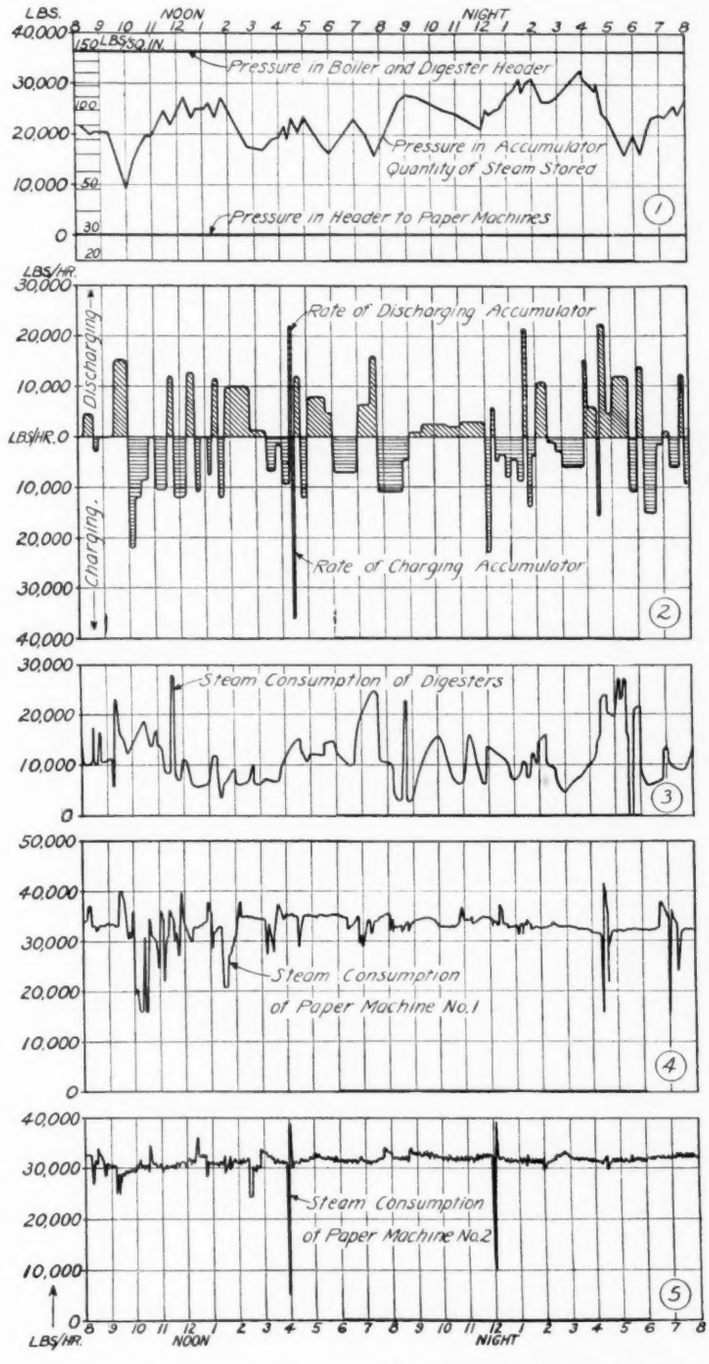


Fig. 8—Steam-flow curves derived from chart for May 4 (see Fig. 7)

on May 8 this pressure was increased from 30 lb. to 35 lb.

An explanation is required for the charts for Saturday and Sunday. On Saturday night at 12 o'clock, production was interrupted, the boiler plant and the Ruths control were shut down and the accumulator supplied steam to the entire mill for heating and various other purposes until 9 a.m. on Sunday. At this time the pressure in the accumulator and the boiler plant had dropped to 45 lb. and it became necessary to recharge the accumulator. This was done, as can be seen from the chart, in 45 minutes by running the electrical boiler at a high rating. This procedure of charging and discharging the accumulator was repeated three times. With this method it is possible to supply the low steam demand during Sundays from the electrical steam generator. This would not be possible without the accumulator, because the electrical steam generator cannot be operated at such a low load as is required on Sundays.

In the diagrams, Fig. 8, an analysis has been made of the performance of the entire plant for the day of May 4. Diagram 1 is a reproduction of the pressure chart showing how the accumulator pressure fluctuates between the two constant pressures of 30 lb. for the paper machines and 150 lb. for the digesters. This diagram has been graduated in pounds of steam stored in the accumulator and in pounds per square inch pressure, so that the same curves indicate both steam stored and the pressure under which it is stored.

Diagram 2 has been obtained from diagram 1 and indicates the rate of charging and of discharging of the accumulator. As can be seen, there are frequent changes between charging and discharging of the accumulator at ratings as high as 20,000 to 30,000 lb. of steam per hour. In diagram 3 has been plotted the steam consumption of the digesters, while diagrams 4 and 5 indicate the steam consumption of the two paper machines.

By comparing the different diagrams, the function of the accumulator can readily be seen. For instance, interruptions occurred in the steam consumption of paper machine No. 2 at 4 a.m. and midnight, and it can be seen from diagram 2 that at the same time the accumulator was charged at a corresponding rating.

It should be remembered, as mentioned earlier in this article, that it is not desired to operate the electrical boilers at an absolutely constant rating, but rather in such a way that the total consumption of electrical energy of the plant is kept constant. It would, however, be entirely feasible to operate the electrical boilers at a constant rating as indicated, for instance, by the zero line in diagram 2, and this diagram would then at the same time indicate the fluctuations in the total consumption of steam.

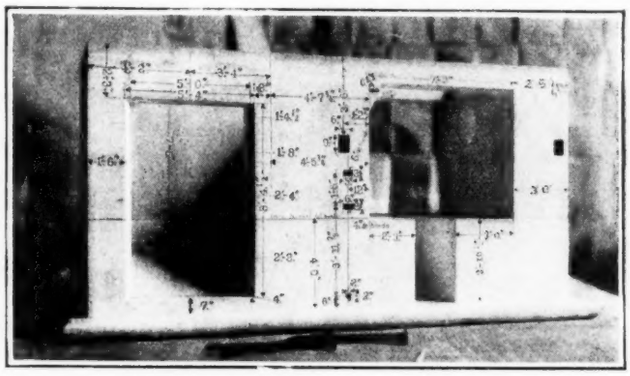
SYNTHETIC AMMONIA IS PRODUCED directly from its elements, nitrogen and hydrogen. Hydrogen, secured by any of the various known methods, is mixed with nitrogen, generally secured from the atmosphere, in the ratio of one part of nitrogen to three parts of hydrogen. This gas mixture is then compressed to from 100 atmospheres (1,500 lb.) to 900 atmospheres (13,500 lb.) and is then passed over a material known as a catalyst at a relatively high temperature of from 800 to 1,100 deg. F., whereupon a portion of this gas is converted to ammonia. On passing out of the catalyst-containing vessel, the ammonia is removed from the gas.

A Working Model for Turbine Foundation

IN THE peninsula of Yucatan, Mexico, the Maya Indian workers are not skilled in deciphering drawings; hence for building a turbine foundation at the plant of the Compañia de Electricidad de Mérida, the masons, instead of being furnished with a blueprint, were given a model with the order: "Build the concrete foundation just like that." They did, successfully.

A new steam turbine of 1,500-kva. capacity was on order from Bellis & Morcom, Ltd., of Birmingham, England. Foundation blueprints were, as is customary, received several months in advance of the arrival of the turbine. The monolithic concrete structure which was shown was rather complicated. G. N. Milke, chief engineer of the property, knew from past experiences that no end of difficulties and possible errors would result if an effort were made to construct the monolith from the print.

Accordingly, the model here shown was built. The woodwork was made by a native carpenter, assistance being continuously rendered by Mr. Milke. The latter



Wooden scale model of turbine foundation

had his troubles at the start in getting the model constructed properly, rather than later in the actual construction of the foundation itself. The model was made accurately to scale one-twelfth size or to a scale of 1 in. to the foot. The wood was Mexican cedar, the most common native wood and that of which most cigar boxes are made. It possesses the advantages of being relatively soft, is easily worked and retains its form. Moreover, it is not eaten by the indigenous insects as are the woods of the pine family.

After the carpenter had finished his work, the model was given a coat of white filler and three coats of flat white paint. Then the center lines, projection lines and dimension lines were drawn in black waterproof drawing ink. All important dimensions, taken directly from the blueprint, were shown. The dimension values were stamped into the wood with steel number stamps, the depressions thus formed being filled in with the ink.

Forms for the foundation were constructed by native carpenters. They took the dimensions and obtained their conceptions as to the shape of the finished structure from the model. These forms were constructed complete and set up in the carpenter shop, for final inspection, measurement and checking, prior to their erection in the foundation location.

Operation of Semi-Magnet Type Elevator Controllers

By CHARLES A. ARMSTRONG

Explains the Difference Between Semi-Magnet and Full-Magnet Types and the Operation and Circuits of Three Semi-Magnet Type Controllers

ELEVATOR controllers may be divided into two general classes, semi-magnet and full-magnet. The semi-magnet types are those used on elevators that are operated by a hand rope in the car. The operator may control the elevator either by pulling on the rope directly or through the medium of a lever or wheel. On the semi-magnet control, the reverse switch is generally operated directly by the operator in the car, through the operating cable, after which the starting resistance is cut out of circuit automatically by a magnet.

Sometimes the semi-magnet control is referred to as a mechanical type. This, however, is not correct, since it would indicate that all the functions of the controller were performed mechanically. In most cases where elevators are controlled with a hand rope, part of the control functions are performed by a magnet or magnets, hence the name semi-magnet control.

Some of the earlier type of elevator controllers were constructed so that all their functions were performed

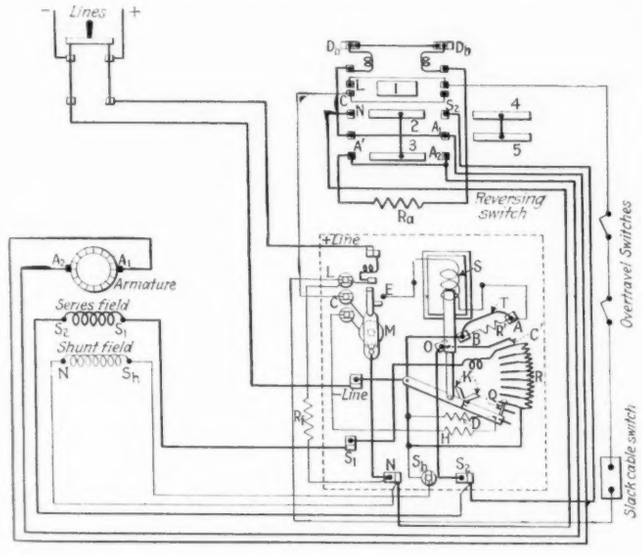


Fig. 1—Wiring diagram for the controller shown in Figs. 2 and 3

mechanically, no magnets being used in their operation. Such control systems may be classed as a mechanical type, but today they are seldom found in use.

Broadly, full-magnet controllers are those in which all the functions of the control are performed by magnets. The initial impulse for starting and stopping the car may be from a car switch or push button, after which the controller completes the operation automatically. These types of controllers may be divided into car switch control, automatic leveling, automatic landing, push button, signal control, dual control, etc., depending upon what the control equipment accomplishes.

Tracing Out Controller Circuits

In this article the semi-magnet control will be studied. Fig. 1 shows the diagram for one type of Cutler-Hammer semi-magnet controller. This has a cylindrical reversing switch, such as shown in Fig. 2. The starting

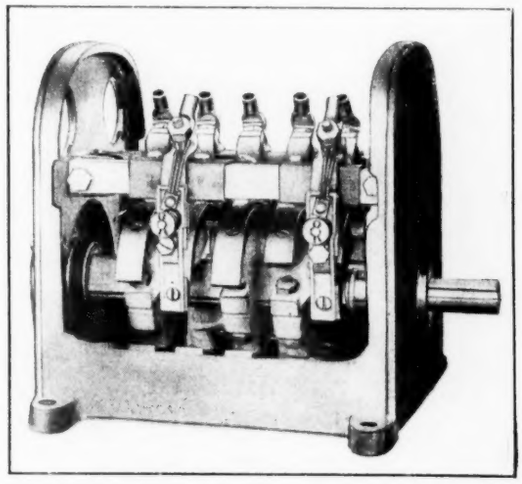


Fig. 2—Cylindrical-type reversing switch

resistance is cut out of circuit by a solenoid *S*, Fig. 3, which moves the arm *F* over the contacts *R*, in much the same way as it is done by hand on the simple manual-type starter. The oil dashpot *P* regulates the time required for the solenoid to cut out the starting resistance. As the dashpot is adjusted for a definite time, the controller is known as the time-limit type. A magnet switch *M* opens and closes the circuit in response to the motion of the reversing switch.

Fig. 1 shows a diagram of the connections with the main-line switch closed and the reverse switch in the neutral position. The parts 1, 2, 3, 4 and 5 are segments attached to the movable element of the reversing switch. If the switch segments are moved to the left, 1 will make contact with *L* and *C*, 2 with *N*, 3 with *A'* 4 with S_2 and 5 with A_1. When segment 1 makes contact with *L* and *C*, it completes the circuit for coil *M* on the main-line contactor. This circuit is from the + side of the line to *L* on the controller, through the slack-cable switch and the overtravel limit switch and to *L* on the reverse switch. From *L* the circuit is through segment 1 to *C*, through coil *M*, resistance *H*, the arm

on the controller to the — side of the line. Completing this circuit energizes coil M and causes it to close its contactor and establish the motor circuits.

The motor's armature circuit is from the + side of the line through contactor M to N on the reverse switch, through segments 2 and 3 to A', and to A_2 terminal of the motor's armature. From here the circuit continues through the armature and returns to A_1 on the reverse

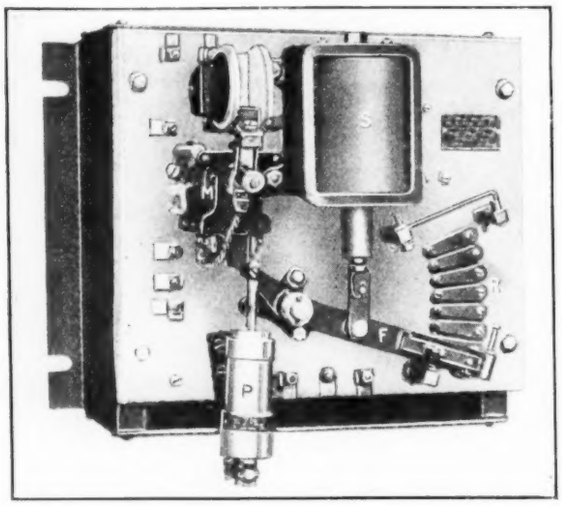


Fig. 3—Semi-magnet type controller for medium-sized motors

switch, through segments 5 and 4 to S_2 on the controller and through the series-field winding back to the S_1 terminal on the controller, through all the starting resistance R and to the — side of the line. Closing contactor M also completes the circuit for solenoid S, from E through coil S to A and through jumper T around resistance R' to the + side of the line.

Energizing S causes it to start raising arm F to cut out the starting resistance. When the arm moves off the first contact, it cuts resistance D in series with coil M and reduces the current in this coil. The reason for doing this is, that it requires much less current in the coil to hold the contactor closed than it does to close it. It also keeps down the temperature of the coil and saves power. When the arm rests on next the top contact, C', the starting resistance R is cut out of circuit and the motor is operating at full speed as a compound machine.

In its top position arm F rests on contact C', and in this position the series-field winding is cut out of circuit. Arm F is also short-circuited by contacts K striking terminals B and O. The armature circuit is now from S_2 at the bottom of the controller to O, then to B and to the — side of the line, without going through the series winding, and converts the motor into a shunt machine. It is necessary to cut the series winding out on a compound elevator motor after it has come up to speed to prevent the elevator from operating above normal speed in the down motion with a heavy load. When lowering a heavy load, the motor is converted into a generator and pumps back into the line, this causing the motor to act as a brake to keep the car under control.

When a compound motor is converted into a generator, the direction of the current in the series winding is reversed and opposes the shunt-field winding. If the series winding were not cut out, the machine would be operating with a decreased field and consequently the braking action would be reduced. To overcome the difficulty, the series winding is cut out of circuit after the motor has come up to speed. Cutting out the series winding after the motor comes up to speed also improves the speed regulation, as a shunt motor has a more constant speed under varying loads than the compound type.

Contact Q on the arm F strikes jumper T, which breaks contact with A when the arm is in the uppermost position. When T breaks contact with A, resistance R' is put in circuit with coil S and reduces the current in this coil, for the same reason as explained for coil M.

Dynamic-Brake Circuit

In this controller the dynamic-braking action of the motor is used to help the mechanical brake stop the elevator. For this reason the shunt field winding is connected permanently across the line. With the reverse switch in the neutral position, the field circuit is from the + side of the line through resistance R_f to N at the bottom of the controller, through the shunt-field winding, back to the S_h terminal on the controller and to the — side of the line. When contactor M closes, the shunt-field circuit is directly through contactor M to terminal N, cutting out resistance R_f. Putting resistance R_f in the field circuit when contactor M opens, reduces the

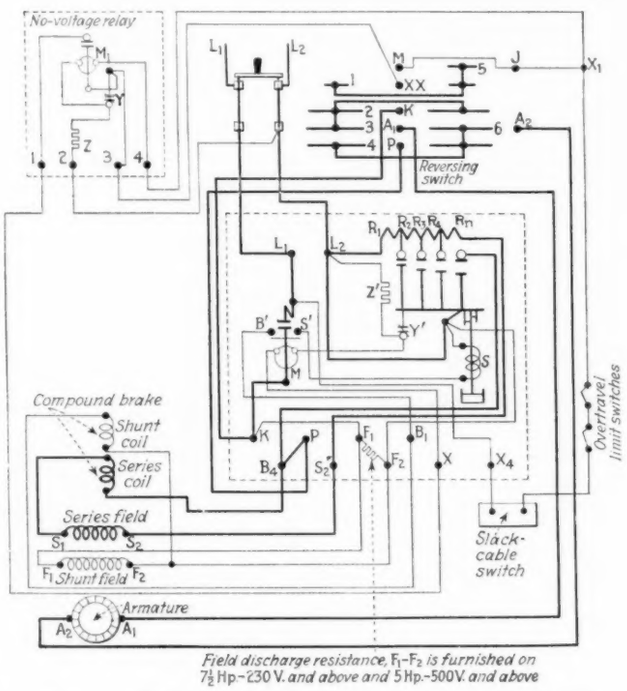


Fig. 4—Wiring diagram for the controller shown in Fig. 5

field current, but at the same time maintains a field to cause the motor to develop a dynamic braking action to help stop the elevator.

To stop the car, the reverse switch is brought to the neutral position by the operator, which cuts the power out of the motor and connects the armatures through resistance R_a. The dynamic braking circuit is from the A_2 armature terminal to A_2 on the reversing switch, through resistance R_a, contacts D_b on the reversing switch and to the A_1 terminal of the armature. This completes the armature circuit for it to act as a gener-

ator during the stopping period. When the reverse switch is in either on position, contacts D_h open and prevent connecting the dynamic braking resistance across the armature.

In the reverse direction, the circuits are the same as already explained except that the reverse switch is closed to the opposite position and the direction of the current is reversed through the armature.

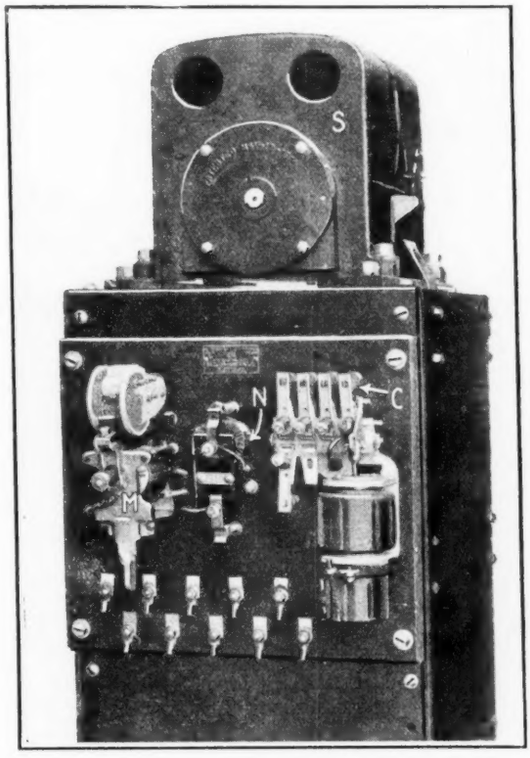


Fig. 5—Semi-magnet type controller combined with reversing switch for medium-sized motors

Controller With No-Voltage Relay

The control diagram, Fig. 1, is for an equipment that employs a brake that is released mechanically. Fig. 4 is the connection diagram of a semi-magnet controller with a compound magnet for releasing the brake. This controller is also equipped with a no-voltage relay to prevent the car starting with the return of voltage, should the controller be left in the on position when power is off the line. The complete control equipment is shown in Fig. 5. In this arrangement the reverse switch S is mounted on top of the controller and can be connected to the shipper wheel on the elevator through a sprocket chain or other form of gearing. On the left-hand side of the controller is the line contactor M and on the right is the accelerating switch for cutting out the starting resistance. In the center of the panel board is mounted the no-voltage relay N. Instead of the resistance being cut out by a solenoid moving an arm over a series of contacts as in Fig. 1, on the controller Fig. 5, the solenoid closes a number of contact fingers C.

In Fig. 4 the no-voltage relay is closed all the time that power is on the line. The closing circuit for this relay is from the L_2 side of the line switch, through resistance Z, coil M_1, the overtravel limit switches, the slack-cable switch to the X_1 terminal on the controller and the L_1 side of the line. As long as this circuit is energized, the no-voltage relay remains closed. If the power is off and the reverse switch is closed, the relay cannot close when power returns to the line, until the reverse switch is placed in the neutral position.

Assume that the reverse switch is closed to the right, then the cylindrical segment 1 will make contact with XX, 2 with K, 3 with A_1, 4 with P, 5 with J and 6 with A_2. Assuming that the no-voltage relay is open and the reversed switch closed, a circuit is provided from the L_2 side of the line through resistance Z and contact Y on the no-voltage relay to contacts XX and J on the reversing switch, around through the overtravel limit switches to the L_1 side of the line. This cuts the closing coil out of the circuit on the no-voltage relay. Therefore with the return of power on the circuit this relay cannot close until the reverse switch is pulled to the off position. When the no-voltage relay closes, it opens contact Y and interrupts the circuit through the reverse switch and prevents the relay coil from being short-circuited.

With the no-voltage relay closed and the reverse switch closed to the right, a circuit is provided for line contactor M, from the L_2 side of the line through the bottom of the accelerating switch, contact Y', coil M to X at the bottom of the controller, through the top contact on the no-voltage relay, to contact XX on the reverse switch and through the limit switches to the L_1 side of the line. Energizing coil M causes it to close its contactor. In doing so, it closes three circuits—one for the shunt coil on the brake, one for the solenoid on the accelerating switch and one for the motor.

The shunt brake coil circuit is from the L_2 side of the line to the F_2 terminal on the controller, through the shunt brake coil back to the control panel, to the B' contact on line contactor M and to the L_1 side of the line. The circuit for solenoid coil S is from the L_2 side of the line through this coil, to contact S' on the contactor M and to the L_1 side of the line. For the motor, the circuit is from the L_2 side of the line, through the starting resistance between R_1 and R_n, through the series wind-

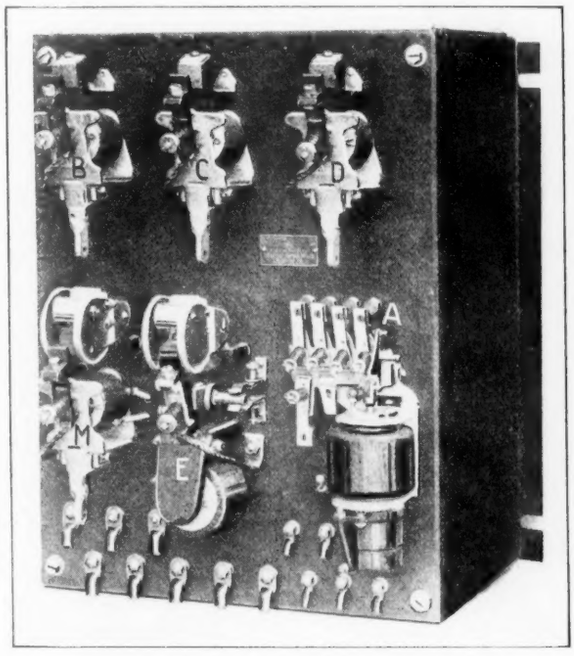


Fig. 6—Semi-magnet type controller for large-sized motors

ings on the motor and the brake to B_4 terminal on the controller and P on the reversing switch, then to A_2 and through the armature back to A_1 on the reversing switch. From A_1 on the reversing switch, the circuit is to K on the controller, through contactor M and to the L_1 side of the line. The combined effort of the two coils releases the brake and the motor starts.

The shunt field of the motor is connected directly across the line to terminals F_1 and F_2 on the controller. As the motor comes up to speed, coil S pulls up its core and closes contactors R_2, R_3, R_4 and R_5, thus cutting the starting resistance out of circuit. Closing of R_5 contact, cuts the series windings out of circuit on the motor and the brake. With the R_5 contact on the accelerating switch closed, the armature circuit is directly from the L_2 side of the line, through contact R_5 to B_4 terminal on the controller and to P on the reversing switch, thus connecting the armature directly to the line and bringing it up to full speed.

When solenoid S closes the accelerating switch, it opens contact Y' and connects resistance Z' in series with coil M. This resistance performs the same function as explained for coil M in Fig. 1.

With the controller, Fig. 4, no provisions are made for dynamic braking and the shunt-field winding circuit is opened each time the motor is stopped. To prevent an excessive voltage being induced in the field winding when it is opened, a discharge resistance is connected to terminals F_1 and F_2. For a short period after the motor is disconnected from the line, the induced voltage in the field coils will cause a current to flow through the resistance and prevent the voltage in the field winding from rising excessively above normal.

Stopping at Top and Bottom Landings

At the top and bottom landings with drum-type machines, the mechanical limits on the drum shaft on the stop balls on the operating cable bringing the reverse switch to the neutral position. On traction-type machines the stop balls on the operating cable are the only mechanical limits. In this way the elevator is automatically stopped. If for any reason the limits failed to function properly, the car would, on passing the floor a short distance, strike one of the overtravel limit switches in the hatchway and open it. Opening of the overtravel limit switch interrupts the circuit to the no-voltage relay coil and causes the relay to open, and opens the circuit to the coil on contactor M. This contactor would then open and cut the power out of the motor and apply the brake.

After the elevator car has run onto one of the overtravel limit switches, the motor cannot again be started until the car is raised by hand or by holding contactor M closed by hand, so that when the controller is pulled to the reverse position, the motor circuit will be completed.

Segments 1 and 5 on the reverse switch are made shorter than 2, 3, 4 and 6. This is done so that the armature circuit will be closed before the coil circuit of contactor M, and will open after the coil circuit to contactor M opens. Thus, all the making and breaking of circuits having heavy currents is done on contactor M, which is designed for this service.

On controllers for motor sizes from 25 to 50 hp., the type shown in Fig. 6 is used. On this type, switch A is not used to cut out the starting resistance directly, but acts as a pilot switch that closes the circuits to the contactors B, C, D and E, which function and cut out the starting resistance. Contactor E opens first and disconnects the dynamic braking resistance from the armature, after which contactors B, C and D close and cut out the armature series resistance. When stopping, contactor E is closed by a spring and connects the armature through the dynamic braking resistance, which causes the motor to develop a retarding force to assist the mechanical brake to stop the car. Contactor M opens and closes the mainline circuit as on the other types of controllers, Figs. 3 and 5.

Selection of Steam Pipe Sizes*

Every engineer has his own ideas of the proper practical size steam pipe to use, dependent upon the correlation of velocity and pressure. However, the determination requires calculation, but this can be simplified by using constants for pipe size and pressure. A convenient equation is

$$P = \frac{L \times S}{V}$$

where P = Pipe factor, equal to 60 times the pipe area in square feet.
L = Pounds of steam per hour.
S = Steam factor, to be taken from Table I and equal to the specific volume of steam at the given pressure.
V = Velocity in feet per minute.

Inserting the known values of L, S and V, the pipe factor P is found, and in Table II the correct size pipe will be found.

TABLE I—STEAM FACTOR

Steam* Pressure	S	Steam Pressure	S	Steam Pressure	S	Steam Pressure	S
0.25	1,237	5	73	25	16	125	3.6
0.50	642	6	62	30	14	150	3.0
0.75	437	8	47	35	12	200	2.3
1	333	10	38	40	10	250	1.8
1.5	22⅝	12	32	50	8	300	1.0
2	173	15	26	60	7	400	1.2
3	118	18	22	75	6	500	0.9
4	90	21	19	100	4	600	0.8

* Steam pressures are in pounds per square inch, absolute.

TABLE II—PIPE FACTOR*

Size	P	Size	P	Size	P	Size	P
1	0.33	5	8.2	16	83.8	48	755
1¼	0.74	6	11.8	20	131.0	54	955
2	1.31	8	21.0	24	189.0	60	1,180
2½	2.05	10	32.7	30	294.0	72	1,700
3	2.95	12	47.2	36	425.0	84	2,310
4	5.25	14	66.1	42	578.0		

* Pipe sizes are given by diameter in inches.

As an example of the procedure, assume that 300,000 lb. steam is to be handled per hour at 400 lb. absolute pressure. What is the desirable pipe diameter if the velocity is to be 8,000 ft. per min.? From Table I S is found to be 1.17, therefore

$$P = \frac{300{,}000 \times 1.17}{8{,}000} = 43.9$$

which in Table II indicates a 12-in. pipe.

Results obtained with this formula and factors are well within practical requirements. However, for accurate calculation attention is called to the fact that the pipe factor P is based on actual inside diameter. This will require correction for actual pipe weight or thickness used for the specific condition. In addition, the steam factor S is the specific volume for dry and saturated steam. Increase S 1 per cent for each 6 deg. of superheat and decrease S 1 per cent for each 1 per cent moisture.

*These tables were developed by the Ernest E. Lee Co.

Coal Preparation and Handling at Trenton Channel

By JOSEPH H. DRAKE
Boiler Room Engineer at Trenton Channel Plant,
Detroit Edison Company

IN last week's issue Mr. Drake traced the coal through the pulverizing mills. This article deals with the wear in the mill exhauster fans, the pneumatic transport system, feeders and burners, means and readiness of control and the operating force.

IN THE mill exhauster fans the blades are replaced about every 10,000 tons of coal milled. Fig. 1 gives some indication of how they wear. Several materials for these blades, such as rubber, brass, copper, micarta, glass, manganese steel, boiler-plate steel, etc., have been tested to determine what material gave the longest service. To date, boiler-plate steel has given the best results and it is carried in stock for this purpose (see Fig. 2). The plow points in the mills are replaced about every 13,500 tons of coal. The most efficient life of rolls and grinding rings has not been determined.

Screw Conveyors

Four screw conveyors receive pulverized coal from the cyclone separators and deliver it to the coal-pump hopper. They have given good service, but it has been found necessary to run the spare conveyors for a few minutes every shift to prevent caking of coal around the casing. Formerly, they required occasional cleaning out, but since regular operation on each shift has been instituted, seldom has it been necessary to remove a cover.

Valves in the lines from the cyclone separators to the screw conveyors used to divert coal to the screw conveyor in use, have leaked slightly on occasion. This leakage is not serious, as the spare conveyor is run every day long enough to clean out any accumulation of coal, but it was considered desirable to develop a tight valve if possible. Accordingly, one was built with two hinged valves seating from the lower side and provided with two clean-out doors for cleaning the valve seats. Each valve seat can be opened or closed individually and can be tightened by means of a screw thread when nearly closed. The valve has been satisfactory and will be used in the new section of the plant.

Coal Transport System

Four screw conveyors discharge into the common hopper supplying the three pulverized coal pumps. Through either of two main transportation lines the pumps deliver coal to the 75-ton pulverized coal bins at the boilers. Although the pumps are rated at 50 tons per hour, the capacity has been increased by replacing the original 50-hp. motor drives by 100-hp. motors. Normally, the mills are now run at 70 to 75 tons per hour. The larger motors give better satisfaction when the coal contains an excess amount of surface moisture, as under this condition more air must be furnished to the pump and the load on the pump itself is greater.

From the abrasive action of the coal the flights at the discharge end of the pump screw wear off gradually and occasionally have to be built up with the electric welder. Stellite has been used at this point by the manufacturer, but so far its use has not been considered necessary at this plant.

The coal transport lines are equipped with electro-pneumatic valves for directing the flow of coal to the bin to be filled. These valves can be controlled by push-button contact at a signal board near the coal pump, and can be closed automatically by the operation of a high bin signal located in the pulverized coal bin. The position of the valves, open or closed, is indicated by lights on the signal board, the low signal in the bin acting when the coal is about halfway down and the high signal showing that the coal is within 18 in. of the top.

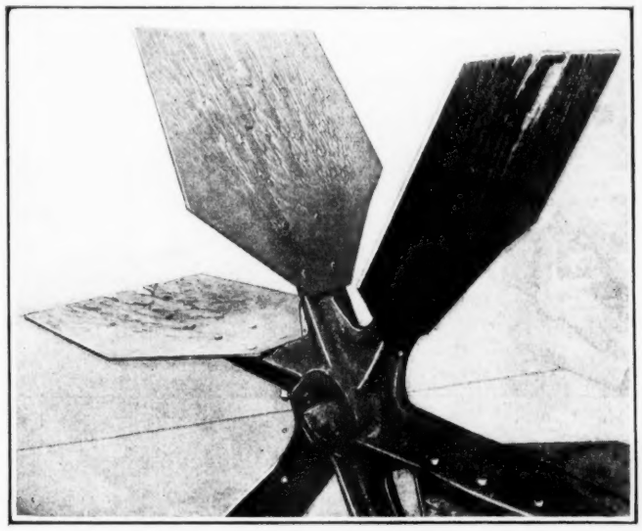


Fig. 1—Exhauster-fan blading after 1,460 hours of service

Pulverized Coal Bins

There are two 75-ton pulverized coal bins to a boiler and each bin feeds eight burners. At the bottom the bin is divided into four hoppers, each feeding through a shutoff gate to a pair of coal feeders. The bins are riveted with flush countersunk rivets and all seams are electrically welded, so there has been little trouble from leakage. Each bin has an opening in the top for a vent line and a removable door for entrance and egress. The door developed for this purpose seats upward. It is hinged to drop down when opened and is held in place by two self-tightening catches. The gasket is made of square rubber set in the door itself.

Each bin is equipped with two signals. The low bin

signal is a paddle swinging on the end of a rod extending somewhat more than halfway down into the bin. When coal is pumped to the bin, it spreads out in all directions. As it flows against the paddle, the movement operates a mercoid switch and breaks the contact to a light on the signal board at the coal pump. The high bin signal paddle, which is about 18 in. from the top of the bin, operates in the same manner. It is equipped with two mercoid switches, one that operates the light at the coal-pump signal board and one that automatically closes the valves directing coal to the bin, allowing it to flow to the next bin on the line. With all boilers running, this permits each bin to be filled in turn, the valves being closed automatically as each one is filled. No action on the part of the coal-pump operator is required until the last bin has been filled, when the bell connected to the last high bin signal informs him that the work has been completed. It is usually desirable, however, to vary the order of filling the bins, and ordinarily the coal-pump operator manipulates the switches by the push buttons on the signal board at the pump.

There is some condensation and caking of coal on the walls, especially where they are exposed to drafts from outside windows. However, this caking of coal on the sides of the bins above the feeder gates, sometimes to a depth of eight or more inches, is not believed to be a detriment to operation, but on the contrary, probably acts to take the place of outside lagging. It builds up on the sides of the hoppers, but has not been observed to overhang the feeder gate opening, nor does it, as far as can be told, drop off in masses that might interfere with the operation of the feeders. On several inspections of the bins the tops of the coal gates in all cases have been found free of wet or caked coal, and there has been no indication of any arching or overhanging at this point.

To prevent coal being fed to a bin on a boiler not in service, with the consequent possibility of spontaneous combustion, the pulverized-coal transport lines are shut off with a slip blank on boilers going down for any length of time. This safeguard obviates the chance of a mistake on the part of the coal-pump operator and guards against any leakage that might occur at the coal switching valves.

Originally, each pair of pulverized coal bins was equipped with two vents, so arranged that the vents of each one were tied together by a Y-fitting to a single pipe venting through the roof. This layout made it possible for coal to get from one bin to its neighbor through the Y-fitting, and it was thought advisable to blank off one side. This was done, leaving each bin with a single vent pipe to the roof. The vents are inspected and cleaned regularly.

Should the high bin signal in the bin fail to operate properly, there would be danger of an overflow through the bin vent pipe. As a precaution relays were installed to ring a buzzer whenever a valve was operated. When a valve did not complete its travel, the contact on the relay could not be broken by the operator in charge, so that he must inspect the valve and make the necessary correction before the buzzer could be shut off. Later, it was decided that an operator on this job was not required, and the relays were disconnected.

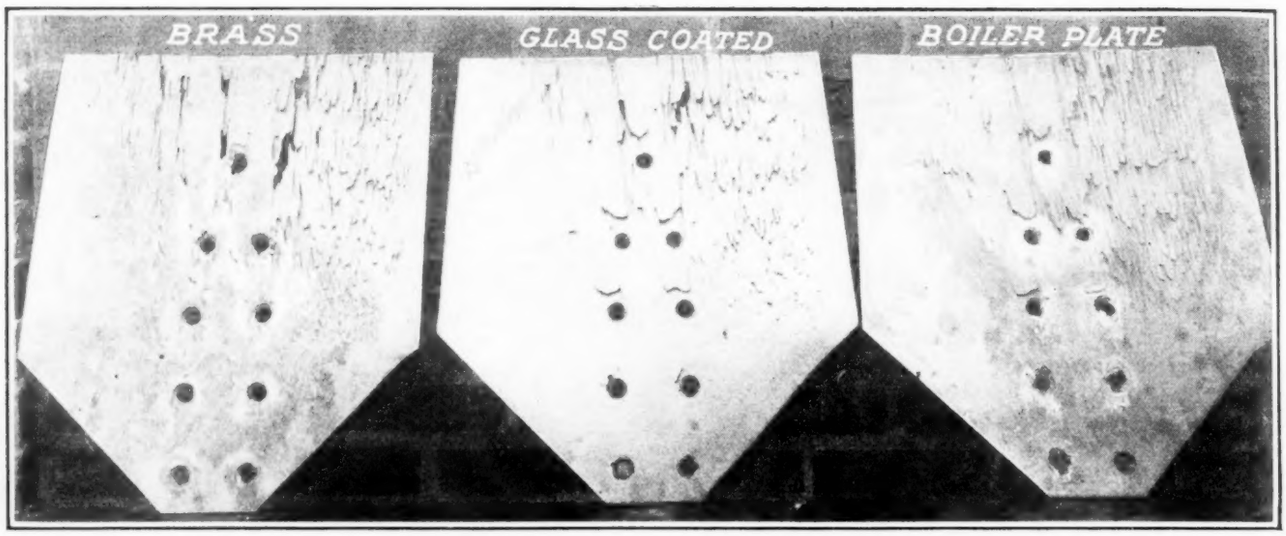


Fig. 2—Exhauster fan blading: Brass after 370 hours of service; glass-coated after 1,025 hours of service; boiler plate after 1,463 hours of service

Once during each shift and at times more often, the valves are operated and the lines to each bin in service are blown out. Poor functioning of the high bin signal is likely to occur when coal is pumped into a bin already nearly full of coal. While it could not be observed directly on account of the dust, the action seems to be a diversion of the incoming coal from its normal path straight toward the bin signal paddle, to a course along the sides and end of the bin, so that the coal strikes the paddle at the back and prevents it swinging in the direction required to operate the signal. Probably the basin-like form that the coal takes directly over the feeders has an effect on the action of the coal flowing toward the paddle, when the coal is close to the ceiling of the bin. The operators are instructed not to pump to a bin that has been filled shortly before. Two high bin signals instead of one eventually will be installed in each bin.

Two rectangular butterfly gates control the entrance of coal to each feeder. Originally, they were designed to operate through an arc of 90 deg., overlapping each other at the center and seating on lips at the outer

edge. It was found that coal packed between the gates and the lips, making it difficult to operate them after a period of service. The lips have been removed and the gates cut off so as to allow them a full rotation of 360 deg., with a clearance between each other and the edges of the casing of $\frac{1}{8}$ to $\frac{3}{16}$ in. Operation was improved greatly, but to keep the gates entirely free from packed coal, they are rotated regularly and the feeder castings are cleaned out when the boiler goes down for repairs.

Burners

Sixteen burners of the fish-tail type, set eight to a side in an arch just below and outside of each mud drum, serve each boiler. Their flat faces are set perpendicular to the line of burners, and the flame is directed downward toward the furnace floor. The draft turns the tips of the flame upward, and the gases pass through each side of the five-pass Stirling boiler and through the economizer to the induced-draft fan.

Tests made with several different burners indicated that a special deflector type was the most desirable. Burners of this type were left on the test boiler and are being installed on all other boilers in the plant.

Each burner casing is equipped with two doors for supplying additional air around the burners. The larger door is left open about one inch for ordinary ratings, and the amount of air increased in proportion to the rating, so that both doors are wide open when the boiler is delivering 300,000 lb. of steam per hour. Occasional cleaning or rapping, usually done when the boiler is coming up after a bank, suffices to keep the burners clear of soot deposits.

The lines from the feeders to the burners occasionally wear at the bends, owing to the erosive action of the coal and air stream. Wear plates at the bends are being considered, and the plans for future installations call for a 5-in. instead of a 4-in. pipe to reduce the velocity of flow and consequently the wear in these lines.

Lighting of the burners is effected by a rag torch soaked in a mixture of kerosene and oil, introduced alongside of the fishtail burner and slightly below it. As the coal used at this plant has a volatile content of approximately 30 per cent, it ignites easily.

A millhouse engineer is in charge of the handling and preparation of the coal from its delivery to the unloading house to its discharge to the pulverized coal bins at the boilers. Under him are the following assistants: One unloading crane operator, under whom are four laborers to clean out cars after using the crane; one man in the coal-handling machinery control room, who watches all coal-handling machinery in general and the long apron conveyors in particular; one man who is primarily responsible for the breaker and short pan conveyors and who is used also as a general utility man; one man in charge of the belts, magnetic pulley and crushed-coal bunkers and two laborers for cleaning. The foregoing work eight hours during the day only. The force of men for the millhouse proper consists of the following for each of the three shifts: One shift foreman in charge of pulverizing and fine-coal transportation equipment, who has under him two mill operators, one coal-pump operator and one man to look after screw conveyors, driers, exhauster fans and the air compressor.

Current for the coal-preparation house is furnished by two 2,000-kw. house alternators in the main turbine room and by a system service line from a near-by substation. Alternating-current machinery is used throughout the building.

Starters for the coal-handling machinery, except those for the bucket elevators and conveying belts, are in a central control room near the coal breaker. The bucket elevator and conveying belt controls are on the crushed-coal-bunker floor. The system is equipped with interlocking relays, so connected that no piece of equipment can be run unless the one ahead of it is in operation.

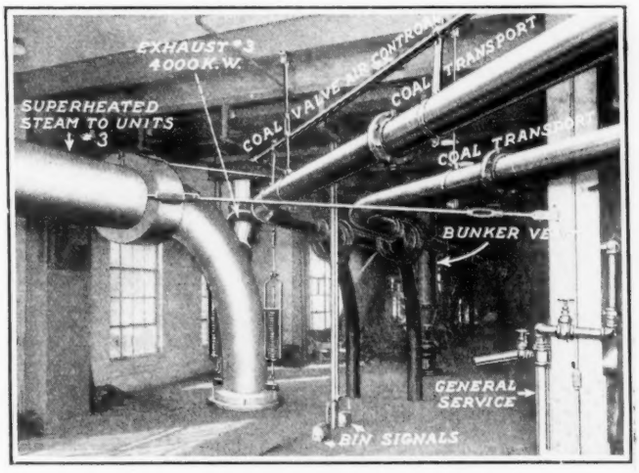
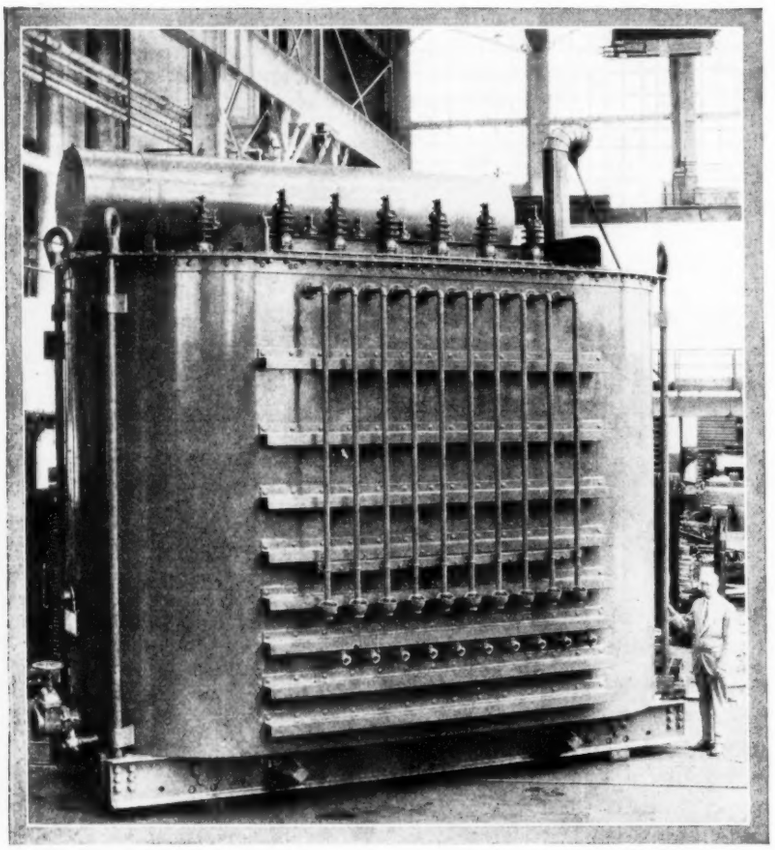


Fig. 3—Top of pulverized-coal bins, showing coal transport lines, switching valves and bin signal casing

To give adequate warning to anyone below, the bucket elevator switch is equipped with a relay that rings a bell in the basement for several seconds before the elevator starts. The bucket elevators are equipped with trip switches that will shut them down in case a bucket should approach its loading chute tipped in a manner that would not permit its entrance. In the drive of the short-pan conveyors is a special switch that will shut down all machinery ahead of the conveyor in case of the breakage of a shear pin between the motor and the drive. At convenient places throughout the coal-handling rooms are emergency switches that may be pushed to shut down all coal-handling equipment and can be closed only by means of a key kept on a board in the control room.

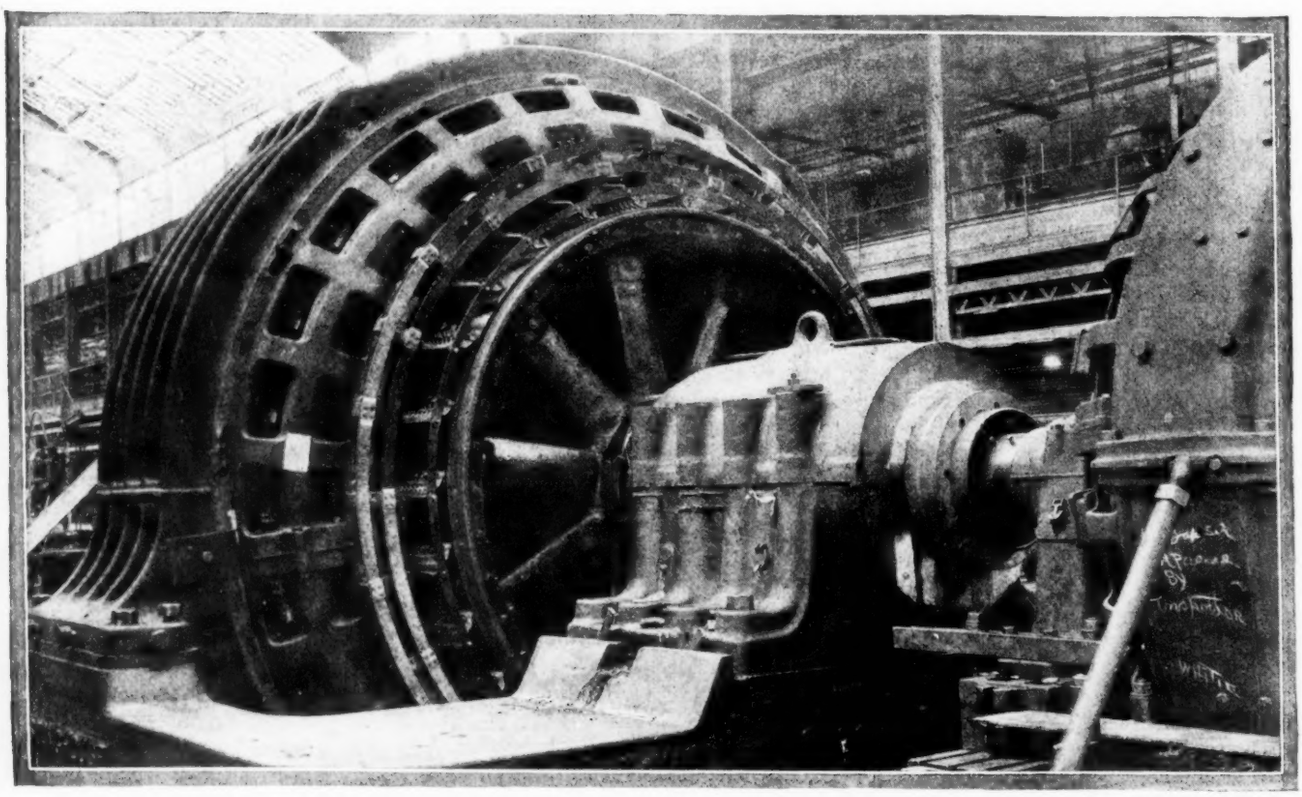
To place the millhouse in operation, an operator turns steam into the drier grids and starts the exhauster fan, screw conveyors and air compressor by switches located near the machines. The transport lines are blown clear with compressed air and the coal pumps started. The mill exhauster fans are started by switches on the exhauster fan balcony, and the mill operator starts the mill from controls on the mill floor. Each exhauster fan, however, can be shut down by means of a push button near the mill control switch. Each screw conveyor has a signal light within view of the mill operator which automatically lights up when the conveyor is started. The hopper over the coal pump is furnished with a bin signal, similar to those in the pulverized-coal bins, that sounds a horn in case the hopper fills up. The mill operator is in close touch with the coal-pump operator, so that, by the means mentioned, he immediately can shut down the mills and exhauster fans whenever necessary. The control of the electro-pneumatic switching valves on the coal transport system is in the hands of the coal-pump operator, through the control and signal board near the coal-pump motor switches.

Each Is the Largest Yet Built



Left — Largest auto-transformer, 66,667-kva. capacity, weighs 122 tons and stands 16 ft. 10 in. high. This equipment was built by the General Electric Company for the River Station in Buffalo

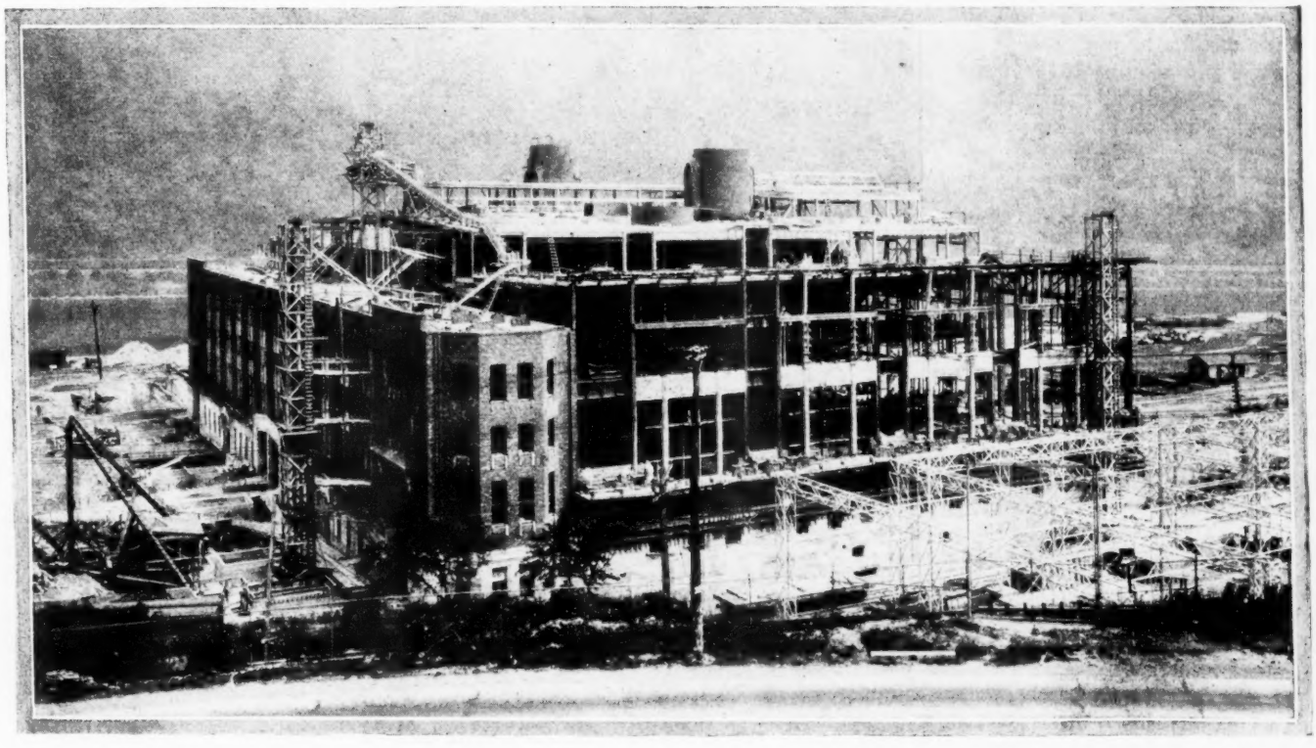
Below — The world's largest direct-current motor, 8,000 hp., 40 r.p.m., has just been shipped from the Westinghouse plant in East Pittsburgh, for steel rolling-mill operation. It weighs 312 tons. The outside diameter of the frame is 20 ft. Current is supplied by a flywheel set consisting of two 3,500-kw. generators, three 50,000-lb. flywheels and a 5,000-hp. induction motor



Work Progresses on New Plants

Right—Gould Street station of the Consolidated Gas, Electric Light & Power Co., Baltimore. This plant is notable for its extensive use of welding, as shown in the Oct. 26 issue

Below—Recent photograph of Stanton plant of the American Gas & Electric Co. near Pittston, Pa. The initial installation will comprise two 40,000-kw. units operating at about 600 lb. pressure



Condenser Study Shows Bad Water Distribution

By JOHN J. GROB and N. ARTSAYOOLOFF
United Electric Light & Power Company.

STUDIES on one of the main condensers in the Hell Gate plant indicate that more attention should be given to the design of the water side of the condenser, to secure more uniform distribution among the tubes. Steam-flow conditions can also be improved.

OVER a year ago temperature exploration tests were conducted at Hell Gate Station on a 50,000-sq.ft. surface condenser with radial steam flow, two water passes and divided sections, each half supplied by a separate circulating pump with a capacity of 35,000 gal. per min. Owing to certain interesting indications, it was decided to explore these conditions somewhat further, and a series of temperature and velocity tests were planned and carried out.

In order to develop a comprehensive picture of the changing conditions on the water and steam sides of a large condenser, it would be necessary to investigate distribution of water among the tubes, distribution of condensation work among the tubes, and steam pressure and temperature drops across the tube bank. The first two investigations have been completed on the condenser and form the basis of this article.

Fig. 2 is a tube-sheet layout for the condenser selected for test. A number of directions radially across the tube sheet in the reversing chamber were selected for investigation and were labeled directions *A*, *B*, *C*, *D* and *E*.

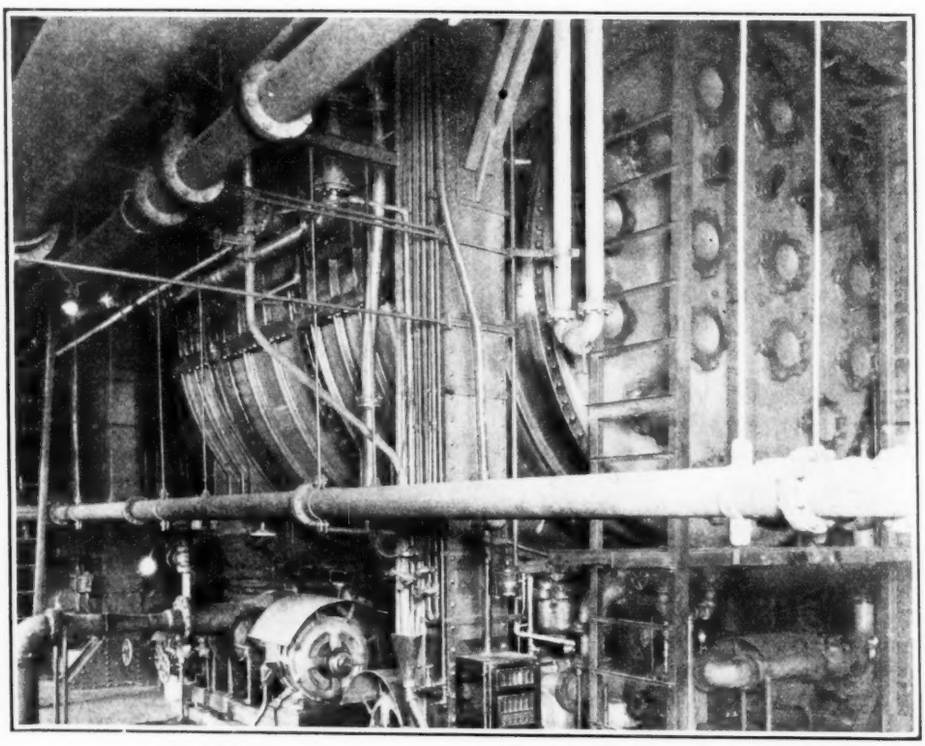


Fig. 1—The condenser was tested in regular operation

It was necessary to construct stuffing boxes and connect them at the end of a nipple and valve on the chosen directions so that a tube could be inserted through the stuffing box and moved across the tube sheet without danger of losing the condenser siphon.

Temperature explorations were made with resistance thermometer elements encased in $\frac{5}{8}$-in. metal tubes about eight feet long and connected to an instrument capable of indicating differences of temperature up to twenty degrees. One bulb was inserted in the inlet chamber, a second one in the tail pipe and a third one was traversed over a series of points along the various directions selected for investigation. Hence the temperature differences were measured with the inlet temperature of the cooling water as a base. Although the load on the unit was maintained fairly steady during the tests, the small fluctuations that did occur affected the total rise, therefore the temperature rise in every investigated point was referred to the simultaneous total rise in cooling-water temperature. Additional connections in the outlet chamber of the second pass disclosed the variations in the total rise across the second pass.

The apparatus proved to be very sensitive, responding in 10 to 20 seconds to the small changes in temperature, but the readings represent the mean of approximately eight tubes just around the point investigated.

For the purpose of measuring velocities at the various points to determine the distribution of cooling water among the tubes, a special Pitot tube was made up consisting of four copper tubes $\frac{1}{4}$ in. inside diameter soldered in a $\frac{5}{8}$-in. brass tube about 8 ft. long. These tubes were arranged as shown in Fig. 3. Thus an instrument was obtained that could transmit a velocity head to a U-tube for measurement. From the sketch of the improvised Pitot tube it is clear that a velocity

head can be measured which represents the water velocity along the test tube and perpendicular to it. By turning the test tube around its axis, the velocities parallel and perpendicular to the condenser tube sheet could be measured. The set was calibrated in a flow of known velocity.

The Pitot tubes were washed before and after each reading to eliminate air bubbles and dirt. This was done by attaching a connection with water under atmospheric pressure, and as the vacuum in the water chambers ran from 5 to 25 in. of mercury, washing was a simple valve manipulation.

As an additional check on the readings the tube was turned 180 deg. and the readings repeated and, if equal to the first set, were recorded. Inequality between the direct and reversed readings showed the presence of air bubbles, and the tube washing was repeated.

Three components of the water velocity were measured—along the tube sheet, perpendicular to it and along the radial direction traversed by the Pitot tube. A general check of the observations was made by

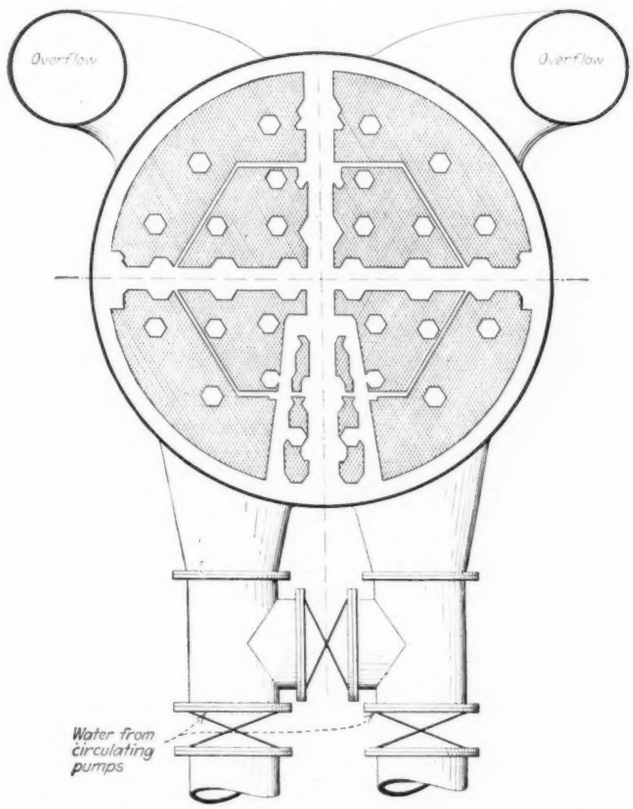


Fig. 2—The inlet and overflow water box is divided into quarters on the vertical and horizontal diameters

Right and left halves are independent, with separate pumps, to facilitate cleaning. The division valve is usually kept closed. In each half, the lower quarter is the first pass.

weighting the average of the velocity readings in each direction and determining the mean velocity. The mean velocity determined in this way was found to be 7 ft. per sec. The velocity computed by dividing the amount of water by the total tube passage area is 7.07 ft. per sec. This appears to indicate a fair average degree of accuracy.

The average distance of the Pitot tube orifices from the tube sheet was 2½ to 3 in., affected somewhat by bending of the test tube. It was not feasible to make the observations any closer to the tube sheet. Upon moving the test tube slowly, one could not detect any sudden change in velocity head, hence the individual jets of water from the tubes were already joined in a uniform flow at this distance from the tube sheet.

Unfortunately, the interference of piping, columns and girders prevented the use of a longer Pitot set and

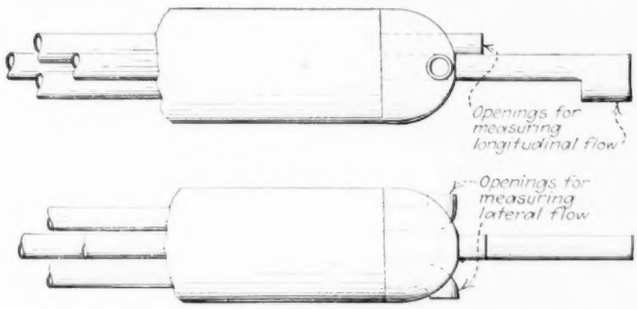


Fig. 3—A special multiple Pitot tube was used to measure velocity components

also made it impossible to investigate direction E_1 in the second pass, and as a basis for the determination of an average velocity and condensation work on this direction, the total flow determined in the first pass was used in conjunction with the weighted averages in the several measured directions in the second pass.

Water Distribution

The water chambers are designed for simplicity and are not hydraulically of the best form. Theoretically, most of the water should be given to the most effective tubes (near the steam entrance), but inequality of flow causes loss of head due to shock when the water strikes the interpass bulkhead opposite the inlet. By properly designing the water chambers it is likely that with the present power of the circulating pumps, more water could be circulated and the average heat transfer raised.

The same conditions may be observed in the reversing chamber where the average water velocity along direction E_1 is twice that of direction E. The water seems to rebound from the top of the reversing chamber, with an increase in static head and this, together with the more direct outlet through the upper region of the second pass, tends to increase the effectiveness of this region.

The water seems reluctant to make sharp turns. This is clear from a study of the diagram of Fig. 4, which indicates that the lower tubes of the second pass average about 50 per cent of the mean velocity and many of the tubes have a reversed flow. The close coincidence between the points of maximum velocity on direction C and minimum velocity on direction D is rather interesting.

The motion of water in the chambers appears to assume the character of whirls or vortices, both large and local, embracing a large portion of the chamber volume. The chambers being irregular, expansion of the water flow must cause a considerable loss of head. For instance, near the point of negative flow on direction B is the center of the large inlet vortex (clockwise). The point of high velocity on A, checked with extreme care, represents the zone where the outflung water of the whirl strikes the streams of incoming water.

Of course the flow of water through a tube depends upon the hydraulic situation at both ends of the tube. The whirling on direction *A* in the reversing chamber seems to be of a local character due to the uneven distribution of tubes and the large spaces free of tubes near this radius. These whirls are inferred from the tube velocity diagrams and the vectorial picture of streams in the reversing chamber corresponds to the section 2½ to 3 in. from the tube sheet and must be considered local. The abrupt changes of velocity through tubes shown on the vectors appear to confirm these assumptions.

Practically everywhere the water velocity through the outermost tubes located on the circumference is relatively low. This may be accounted for by the following considerations: Along direction *A*, the inlet ends of the tubes are in the place of greatest tangential velocity of inlet water and the head available to overcome the resistance of the tubes is reduced by the velocity head of the inlet water and so the velocity through the tubes is low. Along directions *B* and *C* there is back pressure in the reversing chamber in the turbulent zone agitated by the frictional resistance of the chamber walls and the bare spaces on the tube sheet. The magnitude of the back pressure is approximately the average velocity head in the reversing chamber. In the zone of friction the water is relatively almost at rest. On direction *C* this back pressure is overcome by the conversion of velocity head in the inlet chamber into static head when the water rebounds from the top corner of the first pass. Along direction *D* the water is reluctant to make sharp turns, and as the entire body of circulating water flows past this point, the velocity is high. Near direction *E* the tail pipe of the condenser is attached at the side of the upper part of the outlet chamber. Therefore the greatest outlet velocities into the outlet chamber should be in the central partition and the upper corner. On direction *E* velocities would tend to be low near the circumference.

The water velocity diagram gives a complicated flow picture, and the analysis of it is difficult because both inlet and outlet sides of the passes must be considered simultaneously. The four deductions outlined above lead to a congruent picture. It is confirmed again in the exceptional high tube velocity on direction E_1 which was not observed by test, but was calculated to make up the average for the entire second pass. Increase of head in the top corner of the reversing chamber due to rebound from the top and a decrease in the outlet chamber due to the immediate suction of the condenser tail pipe makes this part of the condenser most efficient and the calculated drop appears to be correct.

With a siphon circuit under high vacuum there is always a certain amount of air leakage into the system.

Some dissolved air will also be liberated from the circulating water. The presence of such air was detected in the tail pipe of the condenser. The tail pipe is about 3 ft. 6 in. in diameter, and in the center was found a stream about 6 in. in diameter where the temperature varied abruptly and irregularly over a range of about 10 deg. A Pitot tube inserted into this region vibrated as if under the impact of blows. Inserting the tube farther into the tail pipe diminished the vibration until on full insertion it ceased altogether. The presence of air in the circulating water increases the velocity of the water through the tubes and the resistance of the

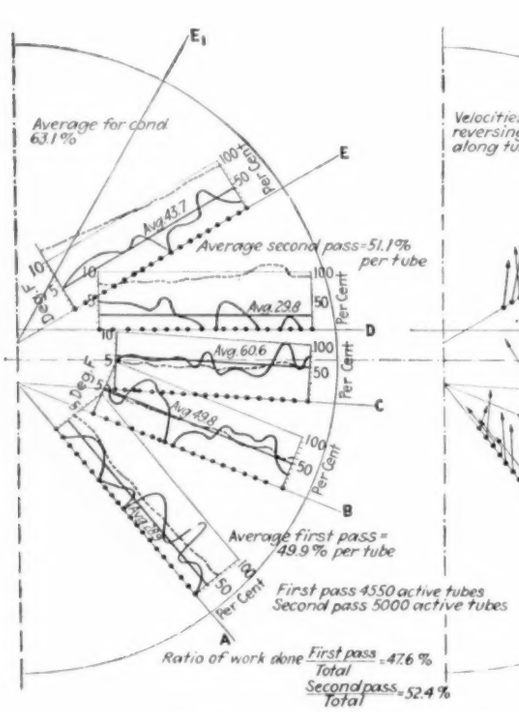


Fig. 4—Temperature rise and heat absorbed per tube

Dotted curves show local temperature rise referred to 10 deg. average rise for the entire condenser, and full curves show heat absorbed per tube in per cent of the average for all tubes.

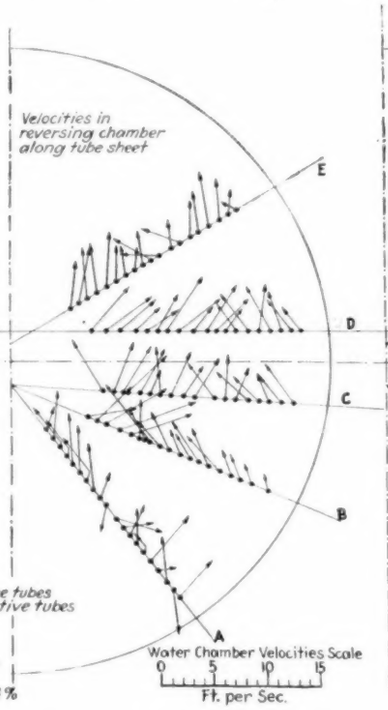


Fig. 5—Water velocity parallel to the tube sheet

The arrows show the direction of flow, and by their length the velocity, to the scale at the bottom. It is evident that flow is very irregular.

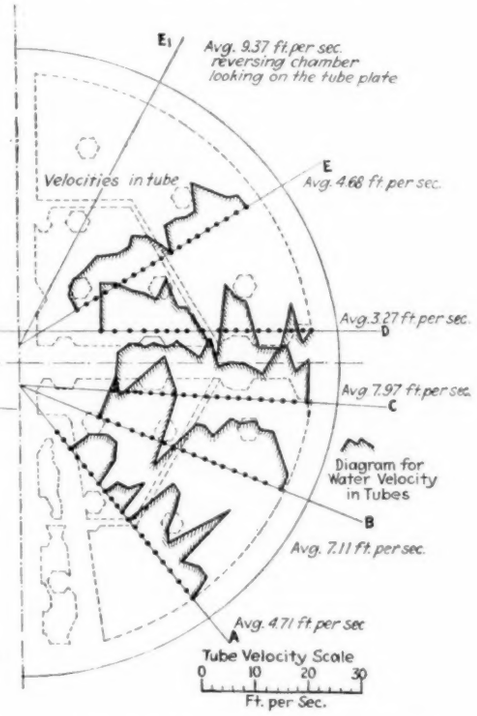


Fig. 6—Water velocity in groups of tubes

The shaded curves indicate velocity by their perpendicular height above the radii on which they are plotted, for groups of eight tubes centering around the dots on the respective base radii.

passage. On the other hand, it increases the turbulence of the water, and on the whole the net effect of air in cooling water, so far as heat transfer is concerned, is probably insignificant.

Non-Uniform Distribution of Condensation Work Among Tubes

The first impression is that the diagram in Fig. 4 appears to show a close relationship between condensation work and tube velocity. This result should perhaps be expected. The average condensation per tube of the first pass is 49.9 per cent and of the second pass 50.1 per cent. The water velocity through the second pass is, however, lower and so too is the mean temperature difference. There is therefore some inherent difference in heat transfer between the first and second passes. The effect of air may be omitted in this case because steam is admitted on the whole circumference. The so-called air cooler must of course be considered integrally with the condenser. Therefore the major cause of difference must be the insulating effect of falling condensate, which adheres to the tube surfaces and blankets them from the steam.

Numerical Evidence from the Test Data

Conditions were approximately as follows: Temperature of water: Inlet, 60 deg.; outlet, 70 deg.; inlet to second pass, 65 deg.; steam temperature 85 deg.; arithmetical mean temperature difference first pass, 22.5 deg.; second pass, 17.5 deg.; ratio of water velocities, first to second pass, 5,000/4,500 = 1.11. Therefore the ratio of heat transfer averages in second and first pass will be

$$\frac{22.5}{17.5} \times \sqrt{1.11} = 1.35$$

This means that the loss of heat transfer from the value for the top tubes of the second pass to the value for the bottom tubes in the first pass is at least 59 per cent. This loss is apparently due to the effect of dripping condensate.

A further effect of the insulating action of condensate is manifested in the drop of condensation work for

TABLE I—COMPARISON OF AVERAGE HEAT TRANSFER FOR ALL TUBES WITH FIGURES FOR PERIPHERAL TUBES AND FOR TUBES JUST INSIDE THE PERIPHERY

First Pass	Average on B	$\frac{49.8\%}{\sqrt{7.11}} \times \frac{17.5}{22.5}$	= 14.6		
	Average on C	$\frac{60.6}{\sqrt{7.97}} \times \frac{17.5}{22.5}$	= 16.7	Average 18.0	
Second Pass	Average on E	$\frac{43.7}{\sqrt{4.68}}$	= 20.2		
	Average on E_1	$\frac{63.1}{\sqrt{9.37}}$	= 20.6		

The Peripheral Tubes				Most Efficient Tubes (Next to Peripheral Ones)			
B	$\frac{25}{\sqrt{3.0}} \times \frac{17.5}{22.5}$	= 11.2		B	$\frac{83}{\sqrt{9.5}} \times \frac{17.5}{22.5}$	= 21.0	
C	$\frac{65}{\sqrt{6.8}} \times \frac{17.5}{22.5}$	= 19.4		C	$\frac{10.3}{\sqrt{10.9}} \times \frac{17.5}{22.5}$	= 24.3	
E	$\frac{16.0}{\sqrt{2.7}}$	= 10.3		E	$\frac{69}{\sqrt{9.1}}$	= 22.8	

tubes at the circumference. Immediately after these inefficient peripheral tubes are the most efficient tubes. The higher water velocity must, of course, be taken into consideration, therefore the ratio of condensation work to the square root of water velocity will be the criterion. For the first pass it will be multiplied by the ratio of the mean temperature differences to make the figures comparable.

The quality of the exhaust steam may be estimated to be about 85 per cent. The moisture of the exhaust steam is deposited on the peripheral tubes which act as a separator for steam at high velocity. The saturated steam, after passing these tubes, probably dried a bit more by some throttling on entering the tube bank, is easily condensed until it loses velocity and temperature with developed partial air pressure. It is a point of interest that the peripheral tubes on direction C which are shielded by a local baffle from the falling condensate, do not show so great a reduction of heat transfer. These tubes are presumably dryer than the average.

Theoretically, almost an equal quantity of steam must enter every square foot of entrance area of the tube bank. Actually, there are variations in the steam flow, if indeed it is radial flow, around the circumference. The steam, therefore, has preferential lanes in entering the bank of tubes. The center toward which the steam is flowing lies slightly above the axis of the condenser, at approximately the level of the staybolts. This condition has a detrimental effect on condenser performance, increasing the resistance to steam passage and reducing the exhaust vacuum.

A point of peculiar interest showing apparent freaks in steam flow may be observed at the innermost tubes investigated on direction E. At the fourth point from the end the condensation is extremely good ($63/25.8\sqrt{5.8} = 26.1$) despite the relatively low water velocity. This can be explained by the relatively fresh steam entering around the baffles which close the vertical passage between the north and south tube banks of the condenser.

Conclusions

An investigation of this character, in addition to disclosing facts of purely engineering interest of possible value for future designs, is useful also to the plant engineer interested in apparatus improvement. Many of the condensers in operation today were designed to contain the maximum cooling surface in a shell of smallest possible dimensions. The steam passages are choked or restricted excessively and such a condition could possibly be remedied during a retubing period by the omission of tubes.

A study of this nature may show that by the removal of some 10 to 15 per cent of the tubes, the steam passages will be enlarged, with a consequent reduction in resistance, and by simple calculations it may be shown that, for example, a reduction of tubing on the circumference of a radial-flow condenser will improve the apparent heat transfer and the vacuum. By apparent heat transfer we mean the heat transfer calculated with the steam temperature taken at the exhaust. The actual steam temperature through the condenser is lower. A loss of 5 or 6 per cent of cooling surface represented by 10 or 15 per cent of the less active tubes will be repaid with interest in the increased steam temperature and consequent increased mean temperature difference. Submitted to such tests, many condensers might also show possibilities for improvement on the water side. The addition of one or two baffles properly located in the water chambers might distribute the water more evenly and put into active work tubes having poor circulation of cooling water.

Regarding Steam Temperatures at Gennevilliers

By R. H. Andrews
Paris representative of Power

Further details on the performance of the equipment under extremely high temperatures, which explain certain rumors as to failures.

AN ARTICLE in the June 15 issue of *Power* described the particularly exacting conditions of service to which had been subjected one of the 40,000-kw. generating units of the Gennevilliers station near Paris, with throttle temperatures varying from 705 to 914 deg. F. Under these extreme conditions the behavior of the turbine was reported as satisfactory on the whole—notwithstanding it had been designed for a throttle temperature of 660 deg., the maximum allowable being set at 705 deg. As a matter of fact, the nozzle diaphragms of the three first stages were distorted in service and had to be replaced; but much of this distortion occurred after the boiler baffling had been modified to reduce the steam temperature.

The conclusions of the station superintendent and the rest of the engineering staff are that turbines can probably be built for throttle temperatures of 850 deg. F. without the use of metals other than those now in use in the latest turbine construction and, in particular, in the last two 50,000-kw. units in the Gennevilliers station.

Therefore, of all the parts of the steam circuit from the boiler to the condenser, the turbine can apparently be best relied upon to give little trouble if specially designed for high temperatures. The steam piping and valves have already proved, in industrial process work, their ability to resist pressure and temperature conditions far in excess of the most extreme thus far proposed for central-station use, although some uncertainty still remains regarding the reliability of cast steel. The weakest link in the chain seems to be the superheater itself. For throttle temperatures between 850 and 900 deg. F. the temperature of the metal in the superheater may be estimated to lie between 1,100 and 1,250 deg. F.; the metal is continually exposed to gases the temperature of which may exceed 2,000 deg. and which are probably always more or less oxidized. It hardly seems possible that ordinary metals could resist such conditions.

Persistent rumors claim that the superheaters in the four pulverized-coal boilers at the Gennevilliers station failed under the tremendous temperatures attained. These superheaters did give some trouble when first put in service, and several of the elements had to be replaced. But this trouble is said to have been entirely independent of the steam temperatures.

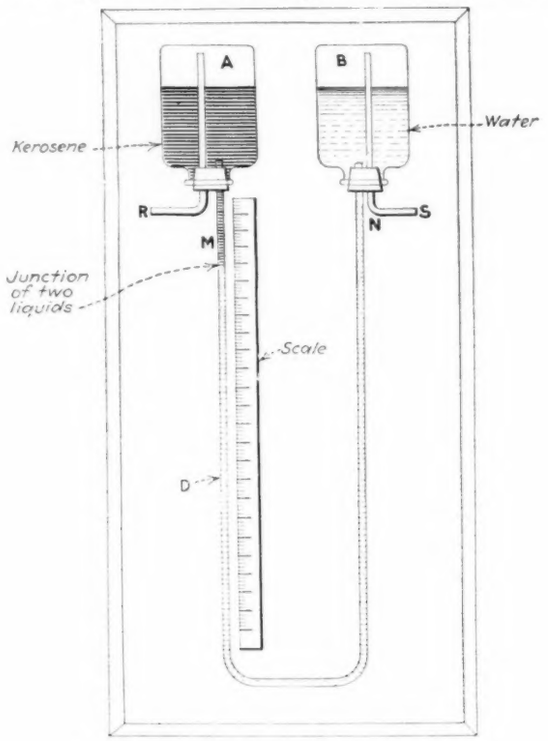
The construction of these superheaters presented several unusual and difficult problems, owing to the fact that the spacing of the tubes and the location of the superheater had been changed considerably from standard American practice. The small clearance between the boiler tubes made certain rather radical departures from current design unavoidable. The construction first tried proved too rigid and unable to resist the stresses set up by expansion.

However, there has been no trouble of any kind since the required structural changes were made. In fact, inspection of the tube surface reveals no trace of burning or even undue oxidation. This is all the more surprising because certain laboratory experiments performed under conditions probably closely approximating those actually obtaining during the several months of high-temperature operation at Gennevilliers, indicated that appreciable burning of the tubes would occur at these temperatures.

How To Make a Two-Liquid Draft Gage

By C. W. Stevens

In measuring differential pressures or drafts that run in the hundredths of an inch of water, it is customary to use the inclined-tube type of draft gage, where the reading is magnified by having one leg of the U-tube lie at an angle. The usual magnification is ten to one.



Use of two liquids magnifies readings

The accompanying cut shows another arrangement that will measure small differences of pressure.

It consists of a glass U-tube, topped with an inverted bottle on each leg. Each bottle contains a second outlet tube, the top of which is clear of the liquid. The outlets of these tubes are connected to the sources of suction and pressure by rubber tubes. Bottle *A* is filled with ordinary kerosene oil, while bottle *B* contains distilled water with a few drops of red ink for coloring.

The point of separation between the two liquids will remain distinct and clear indefinitely. Any pressure in *A* will quickly lower the meniscus, or junction of the two liquids, a distance depending mainly on the difference in density of the two liquids.

The best way to calibrate the scale is to compare it directly with an accurate inclined tube gage. By making the scale movable, the zero point can be set at the meniscus.

Design the Water Side of the Surface Condenser

FOR years the attention of condenser designers has been concentrated on the steam-flow conditions in the surface condenser. Much has been learned, and the knowledge has led to great improvements in condenser effectiveness.

Studies of heat transfer in individual tubes have been attempted during the last decade, and one of their principal results has been the discovery that flow through the tubes is far from uniformly distributed. Tubes nave been found with reverse flow, and direct flow varies from zero to twice or thrice the average for the condenser.

And often it chances that the tubes that receive the least water should have the most, and vice versa. This interferes with good heat transfer distribution and thus lowers the effectiveness of the condenser.

The remedy is to design the water side of the condenser as a piece of hydraulic equipment. As soon as this task is attacked for the tubes, it becomes painfully evident that the usual water-box, with its flat-heads dotted with manholes, with heavy internal flanges and braces, and often with two water inlets facing each other, violates every principle of sensible hydraulic design. This promotes bad water distribution and thus makes it necessary to pump an excessive quantity of water. The power required is doubly increased by excessive quantity and high friction losses.

There are a few condensers in operation that were designed for good water-flow conditions. All condensers should be.

Service Records

HOW many manufacturers maintain systematic "follow-up" and keep service records of equipment after it has left their shops? Some do, but in most cases such information as exists can be found only by digging through files of correspondence; and this usually applies only to apparatus that has encountered difficulties during its early installation period.

Most central stations and many industrial power plants keep complete records of all equipment installed, a card for each piece containing all essential data as to repairs, maintenance, performance, etc., together with the corresponding dates. Such records should prove a source of useful information to the maker, and their consultation would undoubtedly be welcomed by most users.

Service records, properly maintained and intelligently used, may be the means of preventing repetition of mistakes incident to change in personnel; they provide a basis for improvement in design and material, and may be susceptible of profitable interpretations by the sales organization. If properly used, the cost is likely to be insignificant compared with the benefits derived.

Reducing Energy Cost Without Saving Energy

ENGINEERING is full of apparent paradoxes. Here is one. A certain paper mill purchases all the energy it uses. This plant uses a special hook-up which considerably reduces the bill for electricity without reducing the amount of electricity consumed. The average reader, looking for the solution of this conundrum, will probably light on the magic term "power factor." However, the answer here is not power factor but energy storage, as will be seen by studying the leading article of this issue.

In brief, the story is this. The Price Brothers newsprint mill at Riverbend, Quebec, is operated entirely by electrical energy from the large Duke-Price hydroelectric development on the Saguenay River. Electricity is available at such low cost that electric steam generators can be operated more economically than fuel-fired boilers. Large amounts of steam are required at one hundred and fifty pound gage for digesters and at twenty-five pounds for paper machines and heating. To supply these process loads directly through reducing valves would involve continual fluctuations in the rate of steam generation, and hence in the electrical load. Still further variations in the electrical load would come from the fluctuating power demands of the motor-driven equipment.

Since power is bought on a peak-demand basis, any arrangement that will cut off the peaks of the demand curve and fill up the valleys will reduce the total cost of energy even though the monthly kilowatt-hour consumption is unchanged. This is accomplished in the Price plant by using a steam accumulator with two special pressure-regulating governors. The arrangement is such that the electric steam generators can operate at constant load, while the accumulator absorbs or gives off the difference between the steam-generator output and the total process load. It is of particular interest that this is accomplished without varying the pressure on either the digesters or the paper machines. The closeness of the pressure regulation is one of the most interesting results of this installation.

The system is applicable to plants with fuel-fired boilers, the advantages there being reduced boiler investment and better boiler-room efficiency due to constant operation at an efficient load, and increased manufacturing efficiency resulting from the ability to use process steam as desired without waiting for the boilers to catch up or slow down.

Many other plants could profit by a study of the possibilities of steam storage. It must be recognized, of course, that the use of the steam accumulator involves a certain pressure drop, which thus becomes unavailable for power generation. Where power is to be generated, this disadvantage must be weighed against the advantages already mentioned.

The Steam Turbine Has Had a Phenomenal Growth

DISCOVERY of a fundamental principle may occur under almost any circumstance or at any time, but its application may have to await a propitious time, which may be a long or a short period, depending upon the extent of human knowledge and requirements. Probably nowhere was this more true than with the steam turbine. Although the principle of the reaction turbine was discovered over two thousand years ago and that of the impulse type dates back three hundred years, it was not until the latter part of the last century that any effort was made to apply these principles in a commercial machine, the two of which are linked with the names of Sir Charles Parsons and Dr. C. G. P. de Laval.

What undoubtedly was the turning point in the development of the steam turbine, was in 1891, when, by making the unit condensing, it was able to equal the efficiency of the reciprocating steam engine. Many factors have contributed toward making possible the high state of development that the turbine has attained. One of the most important of these is the alternating-current system of power transmission. The steam turbine being inherently a high-speed machine, the alternating-current generator allowed direct connecting without any intermediate gearing. This type of machine was just beginning to come into its own when the turbine came along. It has also made possible the concentration of large capacities in single units and still larger capacities in single power systems.

After making the turbine a condensing unit, its development was rapid. In 1903 a five-thousand kilowatt unit was installed in Hartford, Conn. By 1911 the twenty-thousand kilowatt unit became a reality and 1917 saw the sixty-thousand kilowatt machine come into existence. Since then the increase in size has been somewhat slow until this year, when records have been made and broken with such rapid succession as to make them commonplace.

The crowning event has been the two hundred and eight thousand kilowatt unit for the State Line Station near Chicago. This machine will have a rated capacity of nearly forty-two times that of the historic five-thousand kilowatt unit of only twenty-three years ago. Increasing the span of time to thirty-five years ago, when the turbine was first operated condensing, it has been developed from what might be termed an experiment to a commercial machine of over two hundred thousand kilowatts capacity.

When speaking on "New Fields of Research for Power Development," before the World Power Conference in London, 1924, E. W. Rice called attention to a proposed new station with one-hundred thousand kilowatt units, that would produce a kilowatt-hour on 14,200 heat units. At that time, such a unit was looked upon by many as only a future possibility. However, during less than five months of this year, orders were placed for six machines that had a total capacity of nearly three quarters of a million kilowatts, or an average rating of about one hundred and twenty thousand kilowatts. The proposed plant's thermal efficiency has long since been excelled and gives an indication how fast developments are taking place.

This year saw the size of the largest existing unit increased about three times, and it may well raise the question, Will it ever occur again? These record-making machines will represent a smaller part of their system's capacity than the five and ten thousand kilowatt units installed fifteen or twenty years ago.

Why Consider Only Facts?

THE report of the Federal Oil Commission, that the known supply of petroleum is sufficient for only six years, at the present rate of consumption, cannot be questioned as to the accuracy of the facts. But why should a commission confine itself to facts? Why should not probabilities also be used as a basis of a report?

The history of petroleum consists of a repetition of production cycles, made up of periods of discovery of immense new pools and of time intervals during which these pools were being depleted. An investigation held while depletion was going on could, with perfect honesty, reveal that an oil shortage was impending. Such was the case a score of years ago, when governmental agencies found that the supply would last only seven years. Again, the same general prediction was made twelve years ago, and yet today the output of petroleum is far greater, and in fact the greater portion comes from fields undiscovered at that time.

An investigating body carries a heavy responsibility, and although suggestions to users of oil products that greater care be exercised in the utilization are commendable, it is questionable if great industries should be disturbed by conclusions at the arriving at which future probabilities are not considered. The entire world by no means has been closely examined as to its petroleum possibilities, and it is beyond the ability of any organization to predict safely the actual store of oil underground. Indeed, even in the southwestern part of the United States, where wildcatting is learned in childhood and where some geologists imagine all oil-bearing land is known, new pools come in overnight, completely upsetting the structure so laboriously built up out of facts.

Scientific Auto-Intoxication

INDUSTRIAL development rests increasingly on scientific development, and the man trained in research is becoming more and more essential to industry. This very fact, however, tends to reduce the available supply of trained men, through dislocation of educational facilities. Industrial laboratories are hiring some of the most capable university teachers, and the schools are well-nigh swamped with undergraduate students whose demand for elementary instruction forces the limitation of advanced work. This condition is too unstable to last long. A remedy must be found. Will it lie in larger salaries for the faculties, or in the active discouragement of mediocre students from pursuing college courses, or in closer co-operation between industrial organizations and university research laboratories, or—well, what *is* the answer?

Paint has been known to save coal. Sometimes it saves enough to pay well for the paint used and the cost of applying it. It serves the same purpose in the plant that "close-order drill" does in the army. Neither has any apparent direct connection with the object in view (economy and reliability in the one case and fighting in the other), yet both pay because they keep men in the "doing" frame of mind.

Practical Ideas From Practical Men

Worn Pump Liner Caused Chattering

An unusual case of misplaced blame occurred recently in our station. The high-pressure piston of the triple-expansion pumping engine developed a case of "chatters"; at least we placed the blame there.

Putting cylinder oil in through the indicator cocks did not remedy the trouble, and we came to the conclusion that the piston was loose on the rod, as the chattering would last perhaps an hour then stop probably for a whole watch, and then start all over again. It was imperative that we keep the pump going and hold the pressure on the mains, so the cylinder head could not be removed.

About a week later I came in one morning to find the pump running with such a terrible pounding in the water end that we had to shut down. Upon removing the head on the water cylinder, we found the nut holding the plunger loose two whole turns; after tightening it, we started up again. There has been no more chattering.

Analyzing the case, the conclusion was that the plunger was loose all the time. It was of the hollow-barrel type, and at the end of the stroke it hung over the pump liner more than one-half its length. There was a space of about $\frac{3}{8}$ in., due to wear, between the top of the plunger and the liner; consequently, on the return stroke the sharp edge of the liner, rubbing against the plunger, caused the chattering that we thought was in the steam cylinder.

Rosedale, N. Y. JOSEPH O'BRIEN.

Repairing an Armored Three-Conductor Cable

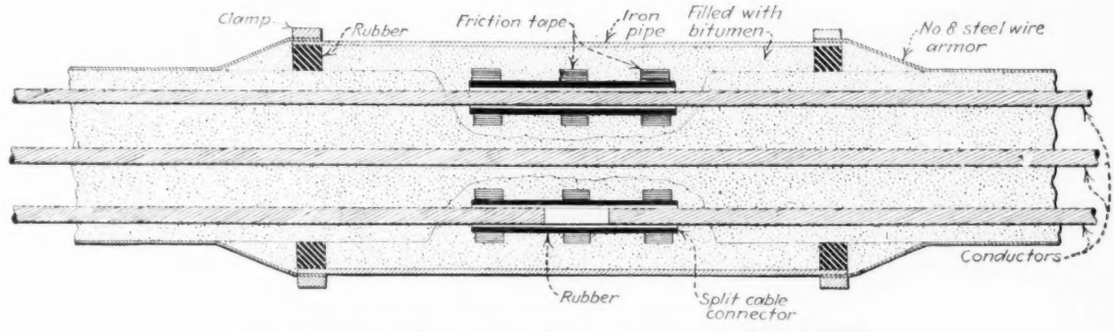
A three-conductor bitumen-insulated, 1,000-volt cable became short-circuited and as a result was badly damaged. One conductor was so badly burned that it had to be cut and spliced. There was no spare cable available of a size suitable to replace the damaged section, so it was decided to make a repair.

How this was done is shown in the figure. To get at the defects in the conductors, the armor, which consisted of 39 strands of No. 8 steel wire, was laid back off the insulation for about 4 ft. Where the failure occurred, the insulation was removed from the cable for about 10 in. Two of the conductors were damaged. The one that was the more seriously injured, was repaired by cutting and soldering into a sleeve.

The inside diameter of the sleeve was about the same as that of the conductor after the outside layers of wire had been removed. The outside wires on the two ends of the conductor were cut back for a distance to allow placing the sleeve on the center core of the conductor. This made a joint about the same diameter as the conductor, which was reinforced by a split cable clamp. The other conductor, which was not so badly damaged, was reinforced by placing a split-cable connector around it. Both of the repaired conductors were then insulated with rubber, after which adhesive tape was wound on at three points, as shown in the figure.

An armor was made for the joint from a piece of iron pipe $2\frac{3}{4}$ in. inside diameter and about two feet long. The tube was split longitudinally so as to be placed around the cable. Two rubber rings were made of a size that would fit between the pipe and the bitumen insulation on the cable. Iron clamps were used at the ends to hold the pipe tightly in place over the rubber rings, after which the space between the pipe and cable was filled with insulating compound poured through a hole that had previously been bored through the pipe.

After the compound had set hard, the clamps were removed from around the pipe. The sharp corners between the ends of the pipe and the cable were filled with bitumen and the wire armor wound in place and over the ends of the pipe. The clamps were again put into place and tightened, thus forming a good mechanical connection between the wire armor and the pipe. After the job was done, the insulation resistance of the cable was tested and found satisfactory. The cable was then put into service and gave no trouble, although it was replaced by a new one some time later.



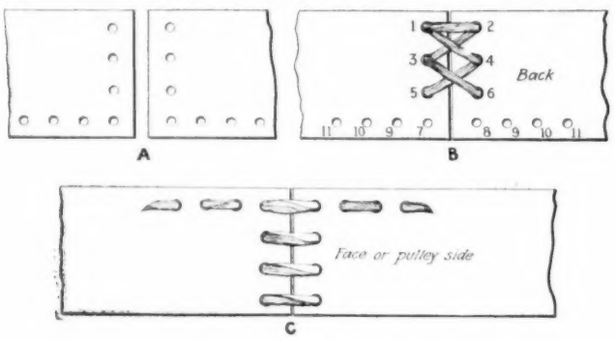
Section through repair made on a three-conductor cable

Shefford, England. W. E. WARNER.

Pointers on Lacing Leather Belts

If a belt is laced in an irregular manner, with the holes punched without regard to uniformity and the laces strung in a haphazard way, it is likely to tear at the holes, leaving but a small part of the connection to hold the joint together. As a belt goes over the surface of the pulleys in this shattered condition, it will catch on the shipper prongs or any other obstruction in its path and an accident may result. A belt thus unevenly supported at the joint cannot run steadily or evenly over the pulleys, and a loss of power will occur.

All leather, rubber, canvas or patent fiber belts used for driving shafting or machinery in any industrial plant should be laced at the joint according to a rule. There must be a joint, for regardless of the kind of belt, it will stretch with service and the stretch must be taken out by cutting a piece out unless other means are provided. There are, of course, types of endless



Steps in lacing a belt

belts, but flat belts are referred to in this article, and these have to be cut, shaped and laced at the joints when necessary.

A strong joint can be made in a belt by proceeding as shown at *A*, *B* and *C* in the illustration. The ends of the belt are first cut even with a sharp knife, and it is a good plan to use a square in doing this so as to insure straight cutting. After the ends are properly cut, a line should be drawn with a scratch awl and square for the row of holes to receive the lace. There should be ample space between the row of holes and the end of the belt to insure strength without using too much lace. A good average for a belt about 6 in. wide is 1 in. from the ends. When the holes are punched the lacing can be inserted into holes 1 and 2 as in the view *B*, and drawn through to the opposite side equally so that the center of the lace will remain across the lap between the two holes, thus forming the first connection in the joint. Then come back again through the same two holes, crossing the lace ends on the face side. Next the laces are passed down through holes 3 and 4 and crossed and brought up again through the same two holes to go down again through holes 5 and 6. The process is simply repeated from one pair of holes to another to the last pair. Whether there are only four pairs of holes, as illustrated, or many more, the principle of lacing will be the same. In order to make the final ends of the laces fast, they can be inserted into holes 9, 10 and 11. In this plan of lacing a belt the crossing of the laces between the pairs of holes is effected entirely on the back of the joint, which side does not come in contact with the pulleys.

The crossing of the laces within each pair is effected on the face of the joint, which side runs against the surface of the pulleys. The completed joint *C* shows how the laces of each pair of holes entwine about each other. Consequently, no flat surface of the lace is offered to the frictional surface of the pulleys for premature wear. A flat surface of the lacing, such as exists in the crosses on the back, as at *B* is likely to wear off quickly and allow the lace to loosen and the belt to come apart. But when the laces are turned about one another on the pulley side, as at *C*, a mixed surface of the lace comes against the pulley faces and even though one part of the lace may become worn, it will be supported indefinitely by a neighboring part. Hence the joint will hold a longer time.

Palo Alto, Calif. GEORGE RICE.

When the Engineer Buys Equipment

Those invested with purchasing responsibility for the power plant often feel an uncertainty when approached by a salesman representing a new house. Wise, indeed, is that engineer or purchasing agent who ever will have his eyes and ears open in the interest of his power plant, irrespective of who the seller is.

There is often too much prejudice against certain companies. Because a piece of equipment has not proved satisfactory in every way, oftentimes due to misunderstanding, a certain house is sometimes dismissed as a possible source for later requirements. This is all the more true when the seller is new. It is well to bear in mind that every manufacturer of power-plant equipment, when first starting in business, is new, and likely unknown. He must make his mark and for this reason is keen upon giving satisfaction. Never should the engineer view a proposition negatively simply because the salesman comes from a new company, for by so doing he may be denying himself the opportunity of procuring excellent equipment unobtainable from others.

Investigate the merits of each house's products. When the engineer is desirous of more information before signing an order, he can inquire as to other users of the apparatus. The salesman, in striving for a sale, will gladly present facts as to other plants using similar equipment.

When the engineer would like to order a given new product, yet refuses because he prefers to stand by the old reliables, he is not making for the best progress. Get the facts from another power plant within easy reach. Incidentally, a visit to some distant plant is often worth while; subsequent ordering of the same product may save a firm thousands of dollars in a very short time.

The engineer should retain all catalogs, go through them, and discuss likely products with others of the plant. No salesman is reluctant to furnish desired information, even though an immediate sale will not be forthcoming. The information that he supplies represents service, and one should be receptive when he outlines his proposition.

The purchasing agent, incidentally, should always work in co-operation with the engineer. Far better purchases result when others of the staff contribute their thoughts and suggestions pertaining to prospective purchases, so minor individuals may well be consulted. Thus the power plant makes for a co-ordination that cannot help but make for satisfactory purchases.

Brooklyn, N. Y. FRANK V. FAULHABER.

Comments from Readers

Starting Corliss Engines

In the issue Oct. 19, there is an article by D. B. Tolton, entitled "Pointers in Operating Double-Eccentric Corliss Engines." I have operated many Corliss engines with single and double eccentrics, and this is the first time I ever heard there was any difference in the operation.

The author relates how an erector insisted that all the valves be hooked up before starting and that there was considerable time and steam wasted until one of the steam valves was dropped on the end that the exhaust was open. I take exception to this statement because the engine could not be successfully operated as he describes.

The common practice is to disconnect the eccentrics, place the valve gear in central position, all valves hooked up. In this position all valves are closed. Tip the gear right or left, open the bypass if a large unit or the throttle if a small unit. Let steam blow through first one end of the cylinder and then the other. While the cylinders are warming up, it is a good plan to oil main bearings, eccentrics and valve gear. When everything is ready to start, hook up the eccentric rod or rods, as the case may be. This operation puts the valves in proper position to run. The steam valve on the head end of the cylinder will be open, while the exhaust valve stays closed. On the crank end the steam valve will be closed and the exhaust valve open. Now then, if the crank is on the upper quarter and steam is admitted by opening the throttle, the engine will surely run. After the flywheel has gained momentum to carry it over the center, the governor may be raised and the valves released or it may be allowed to build up speed to the point where the valves will automatically cut off.

This has been my practice for many years with the best of success. GEORGE W. CLARKE.

Mechanicsville, N. Y.

How Do You Meet Your Executive?

I have read with pleasure Egbert Douglas' article concerning small plants and small-plant management in the June 22 issue of *Power*. In line with this article I would like to add a few observations as to why so few isolated power plants are a financial success.

The manager, usually, has a respectable-looking office, and the chief engineer a very disgraceful engine room. Occasionally, the chief engineer is called into the manager's office, and only too often leaves coal-dust marks on the manager's office rug. The manager feels that he is associating with an inferior person in his chief engineer and does not care to have his visits repeated. The average chief engineer has both cylinder and engine oil on his trousers, unclean collar and unkempt hair covered with a slouch hat or greasy cap. Nevertheless, he expects the chief executive of a company to buy supplies costing thousands of dollars and intrust the same to his keeping when he is unable to keep his own person in presentable condition.

No chief engineer can expect to step into his executive's office and stay there very long if he appears on the job slovenly, dirty and ill-kempt, because any manager who deals with the public in any way realizes that the personal appearance of his employee reflects the quality of the product he is marketing.

I have seen high-pressure sheet packing in sheets 36x72 in. used to stop a water drip from a leaky flange in a water line, until the packing was ruined. In this same plant, instead of discharging the traps of the system to the hotwell and re-using it in the boilers, the makeup was taken entirely from city water, and all trap discharges piped to the ashpits under the hand-fired boilers. This was explained to me as being the cheapest way the chief engineer could find to combat the evils of a smoking stack, and in order to make doubly sure that the plant was not to be fined for smoking, he had put a 1½-in. live-steam header across four boiler fronts, with ½-in. connections over each firing door, so in case the trap discharges did not furnish enough steam to abate the smoke, he could add live steam. Yet this same chief engineer paid 90 cents extra per ton for washed coal because he believed the ash content of washed coal was better than the best screenings he could buy, and he sold the manager on the idea.

A certain plant belonging to a large lumber company had trouble with sawdust flying into the generator windings and motor windings of various motors throughout the factory, because the sweeper did not dampen the sawdust on the floors before sweeping. The chief engineer had repeatedly asked the management to install a blower system whereby the cuttings could be drawn from the various planing machines into a cyclone, and from there delivered to the boilers and burned. The management, however, assured the engineer that the plant had run 20 years as it was, without the additional expense of a suction system, and they did not intend to go to any such expense. Within a very short time after the engineer had given up his efforts to obtain this suction system, a nail in a board was cut in two by the saw. A piece entered between the rotor and the stator of a 50-hp. induction motor. The motor burned up, and the chief engineer was discharged for allowing the power equipment to be in such inflamable condition. After this man was discharged, a salesman sold that company a complete suction equipment for all woodworking machinery. Had this engineer been able to walk into the manager's office and sit down as an equal, he could have sold him on this suction system just as well as the salesman did, but the engineer was an overconscientious workman in overalls, doing labor that should have been done by men employed under him.

Chicago, Ill. CARL WILDEY.

[That Mr. Wildey portrays the average engineer and the average engine room may be open to question, but the picture undoubtedly applies to a sufficient number to emphasize the importance of maintaining appearances in order to command consideration at the hands of the management.—Editor.]

Efficiency in Engineering Schools

I was astonished to read the statement made by the well-known civil engineer, J. A. L. Waddell, in his paper, reproduced in part in the Oct. 5 issue, entitled "Lack of Efficiency in Engineering Schools." He has simply shown his ignorance about the engineering curriculum in the better schools of the country. Being a student in one of the leading engineering schools, I am taking this opportunity to enlighten Mr. Waddell, pointing out his serious mistake in titling his article the way he did.

The lecture system in the colleges was adopted over fifty years ago, when adequate textbooks on engineering subjects were not available. Under such conditions the teacher had to get information for his students from different sources and present it in the lecture hour in a language calculated to enable them to have a clear understanding of the subject. The same topic was assigned for discussion by the classes, ranging from 15 to 25 students. In this way the lecture gave a student a general outline of the subject and the class discussions gave him a thorough understanding.

Lectures are still continued in the engineering colleges to some extent, especially in such courses as physics and chemistry, which form a part of the curriculum. In such lectures the lecturer illustrates the high points by showing moving pictures on the subject and by performing certain experiments which he thinks are necessary to keep the students interested and to show them the relation between theory and practice. Afterward similar experiments are performed by the students in the laboratory under the care of an instructor. If the students did not have some idea of the experiment from the lecture, one instructor could not take care of 15 to 25 students in the laboratory; hence the modern lecture is designed to improve the efficiency of the schools, rather than cut it down as Mr. Waddell thinks.

Three months summer vacations are necessary, for the following reasons:

Besides the mental rest, the student gets a chance to work during his vacations in a factory, thereby obtaining a general idea of the particular branch of engineering in which he is interested.

If there were no summer vacations, a student would not have a chance to know what he was studying, why he was studying, and what were the prospects of the profession he was preparing himself for. During summer vacations a student gets a chance to see the application of the theory that he has been taught in the school, and he also secures an opportunity to apply it himself, which makes his course interesting.

Over 90 per cent of engineering students work in factories to acquire some practical experience, this being necessary in the design courses of the junior and senior years.

Almost all of the deans of the engineering schools see to it that their students work in the summer vacations along their respective lines, and in order to do so, they have organized employment departments. Purdue University has organized a personnel department, which files information concerning the students as to their interest and inclinations toward different lines of the engineering profession. In this way the university assists her students in picking the line for which they are best fitted.

There is a tendency among school heads to make the summer work compulsory for all students, requiring them to present reports on their summer work at the end of the vacations. This enables them to keep track of the 5 to 10 per cent of the students who do not work because of laziness or some other personal reasons.

In spite of all this practical experience acquired by the students in two or three summers, some of the well-known educators think that their students don't get enough information from the summer work to decide for themselves as to where they are fitted the best. To avoid a lot of disappointment after graduation, the senior students are required in the beginning of their senior year to take inspection trips to well-known industrial concerns and public utilities. As a result of such trips the students become aware of personal weak points and try to fit themselves to their chosen lines by re-arranging their subjects for the rest of the school year. Some universities, such as Cincinnati, have started on a co-operative plan, whereby the students are given instructions for two to four weeks in the school and are then required to spend an equivalent time in factories approved by the school. As a consequence a young engineer is given an opportunity to apply the theory that he has been taught in school.

I would like to ask Mr. Waddell whether, in case he had need for a young engineer, he would pick a student with three or four summers' experience, or one who finished his course in three years by attending summer sessions?

MEHAR CHAND,
Lafayette, Ind. Purdue Student.

High-Pressure Steam in Heating Mains

Referring to A. L. Wescott's comment on Prof. J. W. Gavett's article on the new heating plant of the University of Rochester, which appeared in the Aug. 10 issue, I should like to state that the danger from carrying the boiler pressure on the mains and reducing it in the buildings, should be less than Mr. Wescott would have us believe.

It is true that pressure-reducing valves are not infallible. A very small piece of dirt or scale will cause them to act irregularly, but this can be taken care of, and usually is, by careful engineers. In our plant, where reducing valves are used and the piping or radiators are not strong enough to stand full boiler pressure in case a valve sticks open, safety valves are used on the low-pressure side. If the reducing valve should happen to be so far away that the engineer would not hear the safety blowing, an automatic valve may be placed on the high-pressure side of the reducer to shut off the steam when the pressure becomes excessive. In conjunction with this valve a device should be used, so connected that when steam is shut off or the pressure is excessive, it will ring a gong in the boiler room, so that attention will be given to the reducing valve immediately.

I have read Mr. Gavett's article, and I noticed a statement that may explain why boiler pressure is needed. It was stated that high pressure was carried directly through the basement to two of the farther buildings, the Nurses' Dormitory and the new Municipal Hospital, to the latter of which the university sells heat. If the University of Rochester sells steam to the Municipal Hospital, the hospital may demand 100 lb. pressure, and therefore it would be necessary to keep full boiler pressure on the mains.

Mr. Gavett says, "The two mains are, of course, cross-connected so that the demand may be supplied from either one or both"—meaning the 10-in. and 6-in. mains,

which are 700 ft. long. He further says, "It has been the practice so far to carry the load on one of the large units up to about 150 per cent rating. Above this the small boiler is cut in to carry the excess." This load would be about 345 lb. per min. Using Babcock's Formula for flow of steam in pipe lines, the 6-in. line should carry this load with about 9.1 lb. drop, which should not interfere with service unless the hospital needs exactly 100 lb. pressure. Now the 6-in. line with 100 lb. pressure even though covered with 1½-in. 85 per cent magnesia covering, will radiate 167.2 B.t.u. per foot of length per hour, or 117,040 B.t.u. for the whole line. The 10-in. line carrying the same load at 30 lb. pressure would have a drop of about 1.26 lb. and, with same covering as the 6-in. line, would radiate 181.1 B.t.u. per foot of length per hour, or 126,770 B.t.u. per hour for the whole line. Therefore the 6-in. line at 100 lb. pressure will save 9,730 B.t.u. per hour over the 10-in. main with 30 lb. pressure. This I think shows that low-pressure lines are not always the cheapest to operate.

Rockland, Mass. BURTON W. WHEELER.

Order of Opening and Closing Blowoff Valves

The discussion regarding the "Order of Opening and Closing of Blowoff Valves" has been going on for some time and apparently it is, as Charles J. Mason suggests in the Sept. 14 issue, a "matter of opinion and just how the connections are made." In the light of past experience I cannot agree with the opinions of Mr. Vandenburgh in the July 20 issue and can see no reason for Mr. Mason to side with him because of marine practice. As a matter of fact it is a direct argument against the practice advocated; that is, opening the valve closest to the boiler last and closing it first.

In marine work the boiler blowoff valve is connected with the second or sea valve through a section of copper pipe for the purpose of facilitating the pipe work and for better taking up the expansion and contraction. The outside valve is merely a precaution to prevent sea water leaking in and flooding the bilges should the blowoff line break. Really, the boiler valve is the only useful one because if the sea valve is not opened first the full boiler pressure and water-hammer blows will soon blow out the copper pipe. The sea valve is enough larger than the boiler valve so that pressure does not build up in the intervening piping. Blowing down two or three boilers will invariably cause a break, and I still have scars from burns inflicted when an impatient second engineer wanted to save time. The blowoff line came through to the engine room and past the feed pumps upon which I was tightening a packing gland. The water tender had filled the boilers too full and the engineer, feeling that they would prime, tried to blow them all down at once. Following a series of hammer blows the line parted, scalded me and filled the engine room with steam and water before he could close the valves. In spite of warnings I had occasionally blown down two boilers at once, but I never did again.

On low-pressure boilers of 125 or 150 lb. the installation is not so important if the valves are kept up well, but with higher pressures, where boilers must be kept in service, it is necessary to do things right. There is no reason why anyone should hesitate to work on a properly installed blowoff line or valves while the boiler is in service. The properly placed second valve can be packed, reseated, a new plunger or sleeve installed as occasion demands, with but a fraction of the danger involved in blowing down with a plug valve.

In one plant where we have twelve boilers, we clean boilers every six months and overhaul two blowoff valves a month (each boiler has two). The boilers are operated 24 hours a day, with four blowdowns each day. The plant is nine years old, and repairs to the valves are small outside of the labor cost. Last year two plungers were replaced, the year before that two stems and one handwheel which had been broken accidentally. The labor cost is considerable, but we know the valves are right, that they do not leak, and if the packing does happen to blow out it is a simple matter to close the swing-gate valve and repack the other in place without interfering with the boiler. F. BRIGGS.

St. Petersburg, Fla.

Comparative Operating Costs

I have been very much interested in articles in *Power* regarding records of boiler tests, turbine efficiency and general maintenance costs. Why do not these reports show the actual cost of a kilowatt-hour at the switchboard? What is so secret about this cost, and why cannot the man operating a plant know how much more it costs him to produce a kilowatt-hour than it does the large industrial company?

If you pay 7 cents a kilowatt-hour for lights in your home, and it actually costs the power company 1 cent a kilowatt to produce it, what becomes of the other 6 cents? If it is legitimate profit, why can you purchase one kilowatt for 3 cents to cook your meals and have to pay 7 cents and up for the privilege of eating that meal in a lighted room? The off-peak and peak-load costs have been worked to death, and the average operator knows it is the power load and not the light load that drags.

The little plant has been throttled down by every kind of an argument possible, yet many small plants are operating just as efficiently as the larger ones, and owing to the fact that they have to have a heating system anyway, their electrical load is handled by the same men that have to be paid to maintain the heating system.

A certain large industrial company, in order to get a small plant to buy power from it, sent a representative to explain to the plant owner why it could furnish power cheaper than he could make it. After enumerating the usual arguments of cheaper coal, oil and supplies, and the old story of expert engineering service rendered customers, the plant owner asked the representative how often power had been off his line in the last five years. "I do not know," said the representative; "it happens so seldom that we do not keep any record of it."

"We must know this before going further into these negotiations," answered the plant owner, "as every time an electric furnace freezes on us, it costs us $1,500 to clean out the cold pour. Unless your company can show us this will not occur, except at your expense, we will continue to operate our own plant, which has not been off the line once in five years during a heat. With the money we would have to pay for transformers, which without your service are useless to us, we can pay the difference between your coal price per ton and ours for a long time and feel the same security by having something all our own that you have. If my engineer shuts us down, I can fire him, but I can't fire yours."

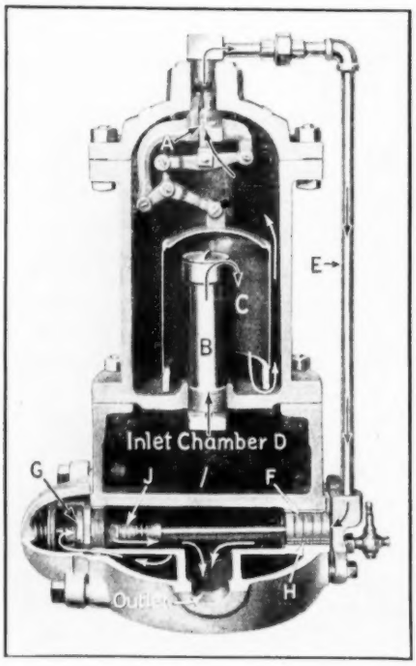
Chicago, Ill. WM. CARROLL.

New and Improved Equipment

New Armstrong Trap of Large Capacity

To meet the demand for a trap that would handle sudden large inflows of condensate, the Armstrong Machine Works, Three Rivers, Mich., has brought out the compound valve trap illustrated.

The new trap incorporates the in-



Piston operated valve gives trap large capacity

verted submerged bucket principle used on the line made for some years by this company and in addition a piston-actuated valve in the base of the trap which allows large quantities of water to be discharged rapidly.

The operation of the trap is as follows: Assume that the upper part of the trap, with the exception of the inverted bucket, is full of water. The bucket, full of steam, is afloat, holding the valve *A* closed. As long as the steam flows into the trap and up through tube *B*, replacing what condenses, the bucket continues afloat and valve *A* remains closed.

Water accumulates in the base or chamber *D* until the bottom of tube *B* is submerged and further flow of steam into the bucket *C* is stopped. Steam in the bucket condenses; the bucket loses its buoyancy and sinks; and, as it sinks the valve *A* is drawn open. The discharge which then takes place through valve *A* and pipe *E* builds up a pressure behind the piston *F* which moves away, opening valve *G*. The opening of this valve releases water from the inlet and base of the trap, and direct discharge takes place through valve *G*, as shown by the arrows.

When the discharge lowers the level in the base until the bottom of the tube *B* is uncovered, steam again flows into the bucket and buoys it up. As the bucket rises, it closes the valve *A*, stopping the discharge through the pipe *E*. When valve *A* closes, the pressure in the cylinder and against the piston *F* is dissipated through the vent *H* in the piston *F*. When this takes place, the flow of water through the valve *C*, together with the spring *J* causes the valve *G* to close and the cycle of operation is completed. The trap continues to discharge as long as water comes to it, and if the flow is small, the water may be handled entirely through the valve *A* and vent *H*. The cap, body and base castings are of cast iron, and the upper valve *A* and the piston valve parts are of heat-treated chrome steel.

A Positive Drive Variable-Speed Gear

A type of positive-drive change gear, known as the "P.I.V." (positive infinitely variable) in which it is possible to alter the speed ratio between a driv-

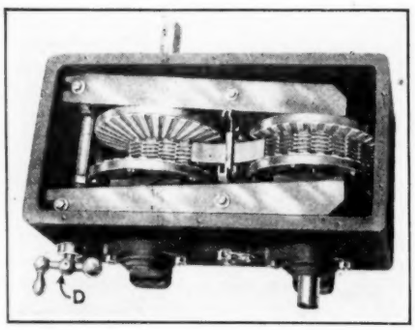


Fig. 1—Change gear assembly with cover removed

ing and a driven shaft to an indefinite degree within the range of the gear, has been developed by the P.I.V. Gear Syndicate, Ltd., 7 Princes Street, Westminster, London, S.W.I.

The essential principle of the gear consists in the use of a driving chain of special construction which runs, if necessary, at short centers between two split pulleys of the opposed conical disk type, one set on each shaft, sloping down at an angle of 30 deg. to the shaft on the inner faces. These faces contain alternate ribs and grooves radiating to the center, which are broader at the pheriphery and narrower at the hub, while also the two halves are staggered in the sense that a rib is always opposite a groove. The chain is engaged at the edges by these ribs, which act as teeth, so that the drive is positive.

The chain consists of composite links formed of plates *A* (Fig. 2) with a longitudinal slot containing a sleeve or casing *B* open at each side, inside of which is a pack of small thin steel plates or slats *C*, which are, however, loose in the sense that each can move in a direction at right angles to the travel of the chain. These slats project in turn from each side into the grooves between the ribs, and in running, as a link enters the V of the pulleys, the ribs or teeth of one side of the pulley push the requisite number of

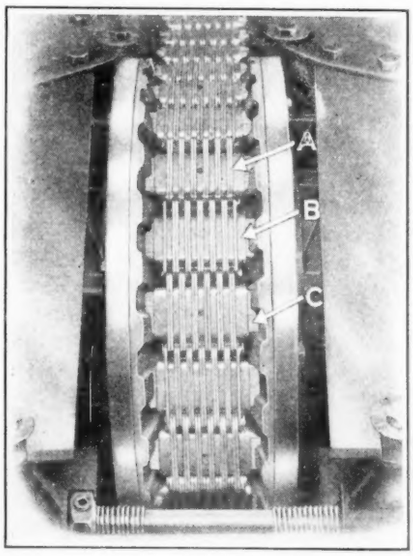


Fig. 2—Shows tooth formation which makes drive positive

slats across into the space on the opposite pulley face. Also to insure continuous and easy running the driving edges of the wheel teeth are not at right angles to the wheel faces, but are inclined somewhat so that there is no possibility of half a slat being necessary to fill the space completely.

To alter the speed of the driven shaft, the halves of each of the split pulleys are made to slide along the shaft by turning the handle *D*, Fig. 1. This operation brings the faces of one pulley closer together and at the same time pushes the faces of the other pulley farther apart, thus changing the relative speed of the two shafts. The whole arrangement can be contained in an inclosed box running in oil or alternately operated as an open drive at long centers.

The smallest standard gear is rated up to 5 hp. and has a speed ratio of 6 to 1, the whole being contained in a closed box 20½x13½x10 in. The next larger size is rated up to 15 hp. with the same ratio and an over-all size of 29x13½x14½ in.

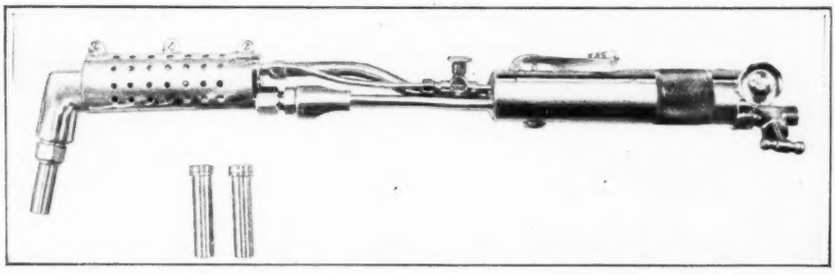
Milburn Oxy-Illuminating Gas Torch

The Alexander Milburn Co., 1416-1428 West Baltimore St., Baltimore, Md., has recently brought out the cutting torch illustrated, for use with illuminating and byproduct gas.

A feature of the torch is the superheater which heats the cutting oxygen to approximately 100 deg. C. prior to combustion, by means of a bunsen burner contained within the torch. The burner uses illuminating gas and heats the oxygen as it passes through a series of copper coils. This increases the temperature of the gases at the torch tip, increases the rate of flame propagation in the burning mixture and materially reduces the oxygen consumption.

It is claimed that the heated and expanded oxygen in conjunction with the illuminating gas gives better penetration into the metal, a narrow kerf, clean edges, speedy and smooth cutting with an absence of metallic slag on the underside of the cut, and, it does not tend to caseharden the surfaces cut.

The torch is constructed of bronze forgings and specially drawn tubing. It is 21 in. in length and is supplied with a complete range of tips for light, medium and heavy cutting. The high-pressure cutting oxygen is controlled by a thumb valve which remains fixed in either the open or the closed position.



Cutting torch for use with illuminating and byproduct gas

Improved Condenser Tube Cleaner and Gun

An improved type of condenser tube cleaner and a gun for holding the nozzle in the tubes when using high-pressure water are recent additions to the condenser cleaning equipment put out by the Condenser Cleaners Manufacturing Co., 422 First Ave., Pittsburgh, Pa.

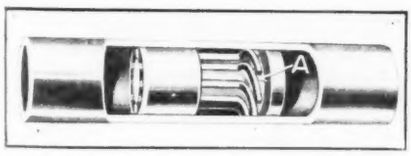


Fig. 1—Improved cleaner with specially formed scrapers

The improved cleaner shown in Fig. 1 is fitted with a number of specially formed scrapers, *A*, which fit the tube closely and tend to shave the deposits from the surface of the tubes.

The gun shown in Fig. 2 is designed for use in cleaning large condensers where the head is not removed and where high-pressure water is necessary to force the cleaner through the tubes. The operation of the gun is as follows: The nozzle *B* is placed in the end of the tube and when the water is turned on at the cock *C*, a piston in the cylinder *D* moves out until the extension *E* comes against the condenser head and serves to hold the nozzle in the tube.

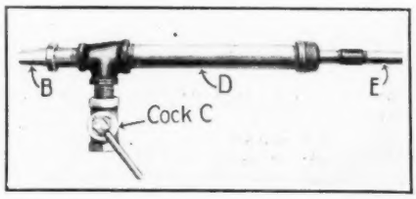


Fig. 2—Gun for shooting the cleaners through the tubes

The cleaners are made in ⅝-, ¾-, ⅞- and 1-in. sizes.

M. J. L. Flow Indicator

The illustration shows a type of flow indicator designed to measure the flow of either gas or liquids under practically all conditions and in any unit desired. The instrument, which combines the well-known orifice and U-tube principles, is made in two styles—for "close hook-up," as illustrated, where the instrument is connected directly to the orifice body, and for "remote hook-up," where the instrument is placed some distance away from the pipe line. In the first case an orifice body with a suitable flange connection for the instrument is used, while in the second case a simple orifice plate is employed between two flanges fitted with special lugs on either side of the orifice plate from which the connections are made to the instrument. The indicator is also made up with a long scale plate where it is desired to cover a wide range of flow.

A feature of the instrument is the provision made to prevent the mercury blowing over. This is accomplished by floating a steel ball on the surface of the mercury in the indicating tube. In the event of the instrument being suddenly overrated or if undue pulsation takes place, the ball comes to rest against a seat and holds the mercury in the tube. Needle valves are provided in the orifice body so that the indicator may be removed or repairs or adjustments made without draining the line. Where the indicator is to be used for steam-flow indication, a small condensing reservoir is inserted in each line to the indicator to keep the connecting lines full of water.

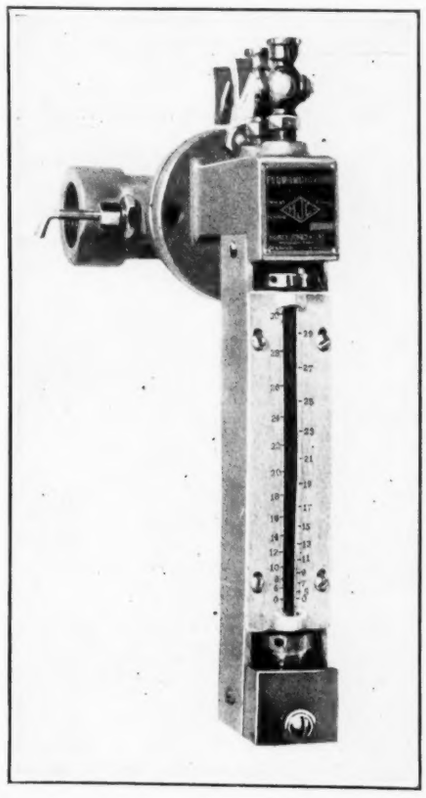


Fig. 1—Indicator with screwed orifice body

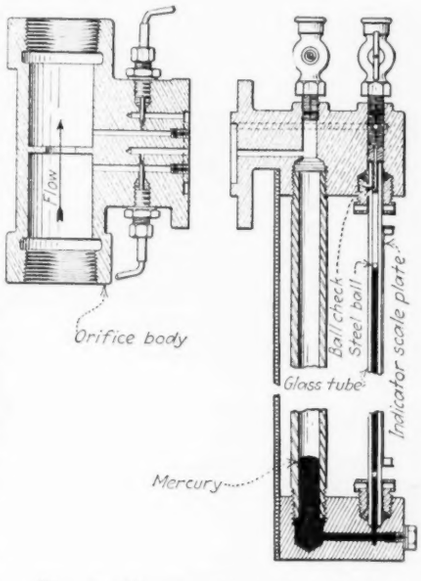


Fig. 2—Cross-section of indicator and orifice body

The instrument is manufactured and distributed by Morey, Jones & Lovell, 810 West Sixth St., Los Angeles, Calif.

News in the Field of Power

Contention for Tennessee River Project Before Commission—Action Soon

Three Conflicting Applications Covering Eleven Dams Before Federal Power Commission, Involving 250,000 Primary Horsepower —East Tennessee Company's Plan

THE staff of the Federal Power Commission has under consideration reports of the field investigation, conducted by the Corps of Engineers, of three conflicting applications for preliminary permits for extensive power developments on the Tennessee River above Chattanooga and its tributaries, the Clinch and Powell Rivers.

The applicants are the Tennessee Hydro-Electric Co., the East Tennessee Development Co. and the Union Carbide Co.

More Than 500,000 Hp. Probable

While the scope of the applications differs considerably, they cover in the aggregate eleven dams, five on the Tennessee, five on the Clinch and one on the Powell, and contemplate the complete development of the power possibilities of the Tennessee River above Chattanooga and the Clinch and Powell Rivers to the vicinity of the Tennessee-Virginia state line.

About 250,000 hp. of primary capacity and a probable installation of more than 500,000 hp. are involved.

Full Investigation Required

Definite action by the commission within the next thirty days is probable. Preliminary permits, if granted, will not authorize any construction work; they will require the complete investigation of the sites specified in the permits and will authorize the permittees to submit, as soon as the investigations and designs can be completed, applications for licenses to build and operate the power structures found to be feasible and adapted to the best use of the rivers.

In addition to the power to be developed at these dams, they would increase the power obtainable at the government dam at Muscle Shoals, and the lower dams would greatly improve navigation facilities on the Tennessee and the lower Clinch Rivers.

Accord with U. S. Engineers

The plans submitted by the applicants are in general accord with the best scheme of development as determined by the Corps of Engineers in the power and navigation survey of the Tennessee River and its tributaries which has been in progress for the past four years.

The East Tennessee Development Co.'s plan is recognized as being of greatest benefit to navigation. Its plan of development was substituted for that contained in two earlier conflicting applications filed by the Tennessee Electric Power Co. and the Knoxville Power & Light Co., which were withdrawn in favor of the more comprehensive plan of the East Tennessee Development Co.

Purpose of Co-operation

The applicants saw nothing to be gained by the conflict and agreed on one project of sufficient size to take care of the needs of both concerns.

The two parent companies have no connection except in this construction and operating company. It was incorporated for the sole purpose of carrying out the project. The stock is owned in equal amounts by the National Power & Light Co., of which the Knoxville Power & Light Co. is a subsidiary, and by the Tennessee Electric Power Co.

Settlement Urgent

Ninety per cent of east Tennessee now is served by the two companies. The total generating capacity, both hydro and steam, of the two companies at present is 212,464 kw., which is barely sufficient to supply the present demands.

If the load continues to grow at the average rate of the past five years, all of the power which it is proposed to develop on the Tennessee will have been absorbed by the end of 1935.

In connection with this application it is pointed out that the demand for power in east Tennessee is such that this project cannot be allowed to await the settlement of the disposition of Muscle Shoals.

Muscle Shoals to Benefit

The primary power at Dam No. 2 and Dam No. 3 at Muscle Shoals, without upland storage, based on the medium low-water year of 1912, is 116,000 hp.

With the East Tennessee Development Co.'s project in operation the primary power at those dams would be increased to 270,000 hp., or a total development for primary power purposes at Dams Nos. 2 and 3 and on the up-river project of 610,000 primary horsepower.

If the Cove Creek dam were built and operated in connection with the Muscle Shoals lease, the best production at the three sites would be 350,000 hp., or 260,000 hp. less than the east Tennessee development.

Were the Cove Creek-Muscle Shoals scheme carried out, the sites on the upper Tennessee would be of no value because, engineers agree, they must be operated in connection with Cove Creek in order to make them of practical value.

Proposes Power Papers for Electrotechnical Meeting

Proposal of a group of important papers in the power field to be presented at the next plenary meeting of the Committee of Action of the International Electrotechnical Commission was decided upon at the last meeting of the committee, which was held in London, Eng., Sept. 23.

These studies, known as experts' papers, are eight in number. They embrace the industrial advantages of the international unification of terms, definitions and symbols related to hydraulic matters and to thermodynamics affecting electric power generation; the necessity for an international rating of hydraulic prime movers for electric power generation and an international rating of steam and internal-combustion prime movers for electric power generation; the problem of the international unification of methods of expressing the capacity and other characteristics of steam boilers, and the problem of defining internationally the characteristics of governors for hydraulic and thermal prime movers; the present state of rating the switches and circuit breakers for both high voltage and heavy current (a) in the United States and (b) in Europe; and the present state of regulations and accuracy of watt-hours.

Tentative proposals for the next plenary meeting, which was to be held in Italy, were outlined by the president, and it was agreed that the meeting of the advisory committee should take place beginning either Sept. 15 or 20, the final arrangements being left in the hands of the president and general secretary.

New Home for Three Oregon Utilities Is Begun

A structure to cost $1,500,000 will be built in Portland, Oregon, to house three public utilities. Guy W. Talbot, president of the corporations whose offices will occupy the building, has announced that excavation will start at once on a fifteen-story building to be known as the Public Service Building. The Portland Gas, Light & Coke Co., the Northwestern Electric Co. and the Pacific Power & Light Co. will use all of the building except six floors. The Northwestern Electric Co. will use the basement for a new substation.

It is expected to have the building ready for use by the early part of 1928.

Lakeside Reports Successful Operation at 1,350-Lb.

The high-pressure plant at the Lakeside station of the Milwaukee Electric Railway & Light Co. is now in regular operation. The boiler, described in *Power* for May 18, 1926, p. 771, has been subjected to a hydrostatic test at 2,100 lb. per sq.in., during which one leak developed at the rate of about five drops per minute. The boiler is now operating at 1,350 lb., supplying its steam to a 7,000-kw. turbine running at 3,600 r.p.m. and exhausting at 317 lb. per sq.in.

Thus far the only difficulty has been the failure under hydrostatic test of the only gasketed joint in the boiler feed line. This was adjacent to the boiler drum in a location where sealing by welding was impossible. These flanges were designed according to A.S.M.E. specifications, which allow too much clearance between bell and spigot permitting soft joint material to squeeze out.

The second gasket has held tight. The turbine runs smoothly and no difficulties are expected. The boiler is equipped with flat glass water-level gages, with the water in direct contact with the glass, no mica being interposed, as has been done in some other installations. The entire system is simple and compact, and there seems to be nothing whatever to fear in the way of operating difficulties.

Detroit Edison to Build New Delray Power Plant

Preliminary work has been started for the construction of a new power plant by the Detroit Edison Co., Detroit, Mich., to be known as the Delray Power House No. 3. This plant will be erected on the same property as the present Delray Power No. 1, which was laid down nearly twenty-five years ago, and No. 2, which was started about fifteen years ago.

The new plant will lie between the older plants and the river bank and is laid out for eight units. Whether these will be 50,000-kw. single-barrel turbines operating on 400 lb. steam pressure as in the Trenton Channel plant, or cross-compound turbines operating at higher pressure has not yet been decided. Likewise, no decision has been made as to the choice of combustion methods and boiler type.

Meanwhile, the general layout is being determined and field work has actually started on foundations for the screenhouse and rearrangement of the cooling-water canal system. It is expected that the plant will be operating within two years.

Substation at St. Augustine Is Now Under Way

Work of driving the piling foundation for the new substation of the Florida Power & Light Co. at St. Augustine, Fla. has started. The piling will all be driven within approximately two weeks, at which time the concrete foundations will be started.

This new substation is being erected as a link in the system, intended eventually to supply the entire east coast with a high-tension power line extending from city to city.

James B. Stanwood, Boiler Manufacturer, Dies

James B. Stanwood, vice-president and consulting engineer of the Stanwood Corp., Cincinnati, Ohio, and inventor of numerous improvements on steam engines and boilers died at his home in that city on October 22.

Mr. Stanwood was born in West Cambridge (now Arlington), Mass., in 1855, and graduated from the Massachusetts Institute of Technology in 1875. Mechanical engineer for the Lane & Bodley Co., until 1886, he later was employed by the Arctic Ice Machine Co., Cleveland, where he remained until 1888.

James B. Stanwood

Returning to Cincinnati, he was one of the original organizers of the Houston, Stanwood & Gamble Co., where he served in the capacity of vice-president and consulting engineer until 1924, and was also in the same capacity until his death, with the Stanwood Corp., the successors of the Houston, Stanwood & Gamble Co.

He was director of the Technical School of Cincinnati until its absorption by the University of Cincinnati in 1900.

His latest achievement is the Stanwood Smokeless Boiler, which is meeting, according to report, with unusual success. Patent No. 1,597,872 has been issued by the U. S. Patent Office covering this improved boiler.

Mr. Stanwood was a member of the American Society of Mechanical Engineers for 37 years, and in this connection he received several years ago a letter of appreciation and congratulation from the council of the society for his active membership of thirty-five years. He was also a member of the American Society of Heating & Ventilating Engineers and the Engineers' Club of Cincinnati.

Mr. Stanwood was the author of a number of technical books, and was a widely known Consulting Mechanical Engineer.

Launching of Two Diesel Electric Ferries

Two of the six Diesel electric ferries that are being built by the American Brown Boveri Electric Corp. for Electric Ferries, Inc., were successfully launched with appropriate ceremonies at the Camden, N. J., shipyard of the corporation Thursday afternoon, Oct. 21.

The event was witnessed by a large number of invited guests, including officials of the United States Navy, state and municipal authorities, and railroad, financial and business interests of New York and New Jersey.

The ferry company will operate all six of these Diesel-engined, electrically driven steel boats between Twenty-third Street, New York City, and the Erie Railroad terminal at Weehawken, N. J., and also between Twenty-third Street and the terminal of the Erie Railroad at Undercliff, N. J.

The power plant of these ferries consists of two New London Diesel engines each driving a direct current generator and exciter on a common shaft. Of the six-cylinder, four-stroke-cycle, single-acting type, they are designed to develop 350 b.hp. each at 280 r.p.m. The bore and stroke are 12¼ in. and 18 in. The generators are shunt-wound open type of 240 kw. at 250 volts and 280 r.p.m. The exciters are compound wound, having a capacity of 35 kw. at 125 volts. The current from the two generator units passes to the shunt-wound direct-current 580-hp. motor driving the through propeller shaft which carries a 3-blade 7-ft. propeller at each end.

Carolina Power & Light Gets Big Pigeon River Project

A fifty-year license for a power project on Big Pigeon River, in Haywood County, N. C., which will ultimately produce 70,000 hp., has been granted the Carolina Power & Light Co. of Raleigh, by the Federal Power Commission, it was learned Oct. 28.

A preliminary permit for this project was originally issued by the Commission to the Pigeon River Power Co., which, however, has surrendered its rights under the permit, it was stated. The Carolina Power & Light Co. has acquired all the rights and interests in the Pigeon River Power Co. by a merger and consolidation agreement with three additional public utility corporations.

The proposed project will consist of a concrete arch dam to be built initially to a height of 130 ft. and ultimately to be 180 ft.; a water conduit about six and a third miles long comprising a tunnel and penstock; and a power house with an installation of 35,000 hp. initially and 70,000 hp. ultimately. The capacity of the project is 23,760 hp.

Benson Springs (Fla.) Station Reports Progress

The Florida Public Service Co. is distributing a booklet incidental to the putting in operation of the company's new Benson Springs power station, located on Lake Monroe, opposite Sanford, and which was erected and started in the record time of seven months.

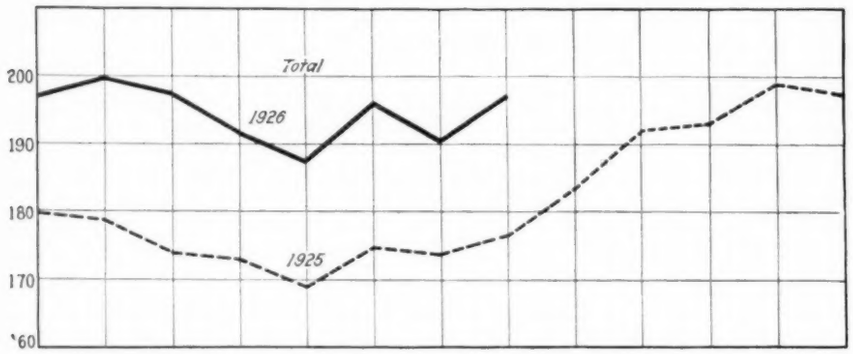
Public Utility Production of Electrical Power, June, July and August, 1926

ACCORDING to the report compiled by the Division of Power Resources of the Geological Survey, Department of the Interior, on the production of electrical power by public-utility plants in the United States for the period of June, July and August, the average daily product in August in thousands of kilowatt-hours, was 197,430,000, or about 3.5 per cent larger than the average daily output for July, August's total, by fuel and water power, being 6,120,232, in thousands.

Production by the use of fuels for these months totaled 11,595,414 thousands, and by water power 6,317,795 thousands, hydro-electric generation thus showing a percentage of 54.5 of the production by fuel. It will be seen, however, that the average daily production of electricity by the use of water power in August returned to normal, due largely to the improved water supply in power streams which was brought about by precipitation.

The curve of average daily total production for 1926 indicates the usual increase in the demand for electricity during the latter half of the year.

Quantities given in the table are based on the operation of all power plants producing 10,000 kw.-hr. or more per month, engaged in generating electricity for public use, including central stations, electric railway plants, and certain other plants that contribute to the public supply. Reports are received from plants representing over 95 per cent of the total capacity. The output of those plants that do not submit reports is estimated to as close an approximation as possible.



TOTAL PRODUCTION OF ELECTRIC POWER BY PUBLIC UTILITY PLANTS, JUNE, JULY AND AUGUST, 1926, IN THOUSANDS OF KILOWATT-HOURS

U. S. and Divisions	Total 1926 June	July	August	Percentage Change in Output from Previous Year July	August
United States	5,878,693	5,914,284	6,120,232	+ 10	+ 12
New England	388,346	377,987	410,462	+ 2	+ 10
Middle Atlantic	1,577,599	1,558,280	1,630,368	+ 7	+ 10
East North Central	1,374,485	1,381,452	1,462,026	+ 12	+ 15
West North Central	374,689	383,689	386,406	+ 10	+ 7
South Atlantic	553,748	569,873	590,069	+ 14	+ 17
East South Central	253,740	250,753	250,949	+ 18	+ 17
West South Central	201,498	211,387	215,450	+ 13	+ 14
Mountain	291,903	295,872	309,400	+ 9	+ 10
Pacific	862,685	884,991	865,102	+ 10	+ 9

Engineers and Public Will Visit New Kearny Plant

A series of receptions from Nov. 9 to 20 will mark the opening of the Public Service Electric & Gas Co.'s $30,000,000 power plant at Kearny, N. J., it has been announced. Public officials, engineers and leaders in the electrical industry will be received at the plant Nov. 9.

Public Service security holders will be invited to visit the plant Nov. 10 and 12, and Nov. 15 has been set aside for industrial power users, Nov. 16 and 17 for clubwomen and other social leaders, Nov. 18 and 19 for the general public and Nov. 13 and 20 for Public Service employees.

The Kearny plant was described in *Power*, Aug. 31, 1926, on p. 306, and in the *Electrical World* for Aug. 27. It is the latest addition to the Public Service Electric & Gas Co. system.

Cumberland Project May Be Abandoned for "Beauty"

Because of the organized opposition of the scenic beauty associations, the Cumberland Hydro-Electric Power Co. is understood to be on the point of withdrawing its application for rights on the Cumberland River in Kentucky.

Those who prefer to see this power utilized for the upbuilding of the surrounding region point out that the scenic associations by no means have established a case, as peculiar conditions at Cumberland Falls make it possible to develop in such a way that all the water necessary to preserve the beauty of the falls will be available.

Local opinion is said to be aroused by these outside activities that promise to rob the region of more than 100,000 hp. to no purpose. The power company has expended great effort to work out a plan of development that will improve rather than detract from the beauty of the falls, but it is understood to be ready to abandon the project rather than insist upon a course that seems to be antagonizing the public in other states, if not in its own.

A.S.M.E. Rules for Coke Burning Issued

One of the recent activities of the Fuels Division of the A.S.M.E. has been the formulation of a set of rules for the burning of coke in domestic heating equipment.

Covering the different stages of coke burning, the rules include instructions for starting the fire, carrying the heating load and banking. They were prepared for the society by J. F. Barkley, fuel engineer of the United States Bureau of Mines.

Copies may be had gratis upon application to A. B. Flagg, Secretary Fuels Division of the American Society of Mechanical Engineers, Engineers Societies Bldg., 29 West 39th St., New York City.

Personal Mention

Herman Heink is at present superintending a large power plant job at Shreveport, La., for the Urbauer-Atwood Co.

George G. Bell, manager of power development for the West Penn Power Co., Pittsburgh, Pa., will leave shortly for a vacation trip around South America.

H. W. Brooks, consulting engineer of the Fuller-Lehigh Co. was a recent visitor in St. Louis, Mo., and attended the local section meeting of the A.S.M.E. on Sept. 24.

W. H. Driscoll, president of the American Society of Heating and Ventilating Engineers, will speak on "Heating the Skyscraper," before the Wisconsin Chapter in Milwaukee, November 10.

Albert T. Kohler has left the employ of the Arkansas-Missouri Power Co. at Walnut Ridge, Ark., where he held the position of district superintendent, and he reports that he is now associated with the York Railway Co., York, Pa.

Louis C. Datz, chief engineer of the Newman, Saunders & Co., who are reorganizing the United Railways Co., was recently elected president of the St. Louis Alumni Chapter of the Phi Kappa Sigma Fraternity.

Robert L. Blanding, mechanical engineer with Jenks & Ballou, of Providence, R. I., expects to sail this week for a trip to Europe for a study of developments in heat and power engineering.

Ivan Lamphier, Berlin, N. Y., has accepted the position of superintendent of a power plant at Springfield, Ohio. Mr. Lamphier took up his new duties Nov. 1. Mr. Lamphier has been employed with the General Electric Co. at Schenectady. He is a graduate of the University of Michigan.

Prof. Thomas Eyre, for many years at Purdue University and the Case School of Applied Science, and more recently Dean of Engineering at the University of New Mexico, becomes professor of mechanical engineering at the University of Southern California this fall. He is the author of "Engines and Boilers," a textbook widely used by engineering colleges. A member of the American Society of Mechanical Engineers, he belongs also to the Society for the Promotion of Engineering Education.

Business Notes

The Buffalo Forge Co., Buffalo, N. Y., announces the appointment of Leon E. Haynes as assistant advertising manager.

The Allis-Chalmers Manufacturing Co. is opening a branch office in Jackson, Mich., with L. F. Berry as resident representative. This office is at 512 Reynolds Bldg., and is a branch of the company's office in Detroit.

The Link-Belt Co., Chicago, reports that it has extended the horsepower range of Link-Belt Silent Chain Drives available from distributors' stocks, from its present scale of ½ to 10 hp., in practically any reduction from 1 to 1 up to 7 to 1, up to 15 hp.

The Walsh & Weidner Boiler Co., manufacturers of water-tube and tubular boilers, at Chattanooga, Tenn., has accepted the resignation of Harold A. Brangs, who has been associated with the company for the last three years as sales engineer. Mr. Brangs leaves to take charge, in association with Clarence Emil Doll, of the sale of the Vorticose Dust Collector manufactured by the Dust Recovery, Inc., 15 Park Row, New York City.

The Sullivan Machinery Co., Chicago, announces the appointment of J. E. M. Schultz, as manager of its office in Dallas, Tex., to take the place of D. H. Hunter, who has resigned. Mr. Schultz has been associated with the company's office at Knoxville, Tenn., in charge of business in North and South Carolina, Georgia and Florida. The Sullivan office at Dallas is at 522 Santa Fe Bldg., where a warehouse and service station are also maintained.

Trade Catalogs

Industrial Thermometers—The C. A. Tagliabue Manufacturing Co., 88 Thirty-third St., Brooklyn, N. Y., has published a condensed catalog No. 625A on the very comprehensive line of thermometers for power and industrial plants. The first part of this issue deals with thermometers of standard construction and materials, and gives specifications. The second part relates to the "specials" of the company.

Centrifugal Boiler Feed Pumps.—The Pennsylvania Pump & Compressor Co., Easton, Pa., has issued Form 325, illustrative of the centrifugal boiler-feed pumps, suitable for boiler pressures from 300 to 500 lb., manufactured by the company, of standard construction. All internal stationary parts of these pumps are held in place against rotation and axial movement by means of lugs and shoulders without the use of pins, screws or dowels.

Industrial Unit Heaters—The Buffalo Forge Co., N. Y. In this catalog, No. 466, are described the various types of unit heaters manufactured by this company, with suggested applications for each. These include the Breezo-Fin, Vento, Hi-Pressure Unit Heaters and direct-fired heaters.

Coming Conventions

American Engineering Council. Annual meeting at Washington, D. C., Jan. 13-15. L. W. Wallace, 24 Jackson Place, Washington, D. C.

American Society of Heating and Ventilating Engineers. Annual meeting at St. Louis, Mo., Jan. 25-28; A. V. Hutchinson, secretary, 29 West 39th St., New York City.

American Society of Mechanical Engineers. Annual meeting to be held at Engineering Societies Bldg., 29 West 39th St., New York City, Dec. 6-9. Dr. Calvin W. Rice, secretary.

American Society Refrigerating Engineers. Annual meeting will be held at Hotel Astor, New York City, Dec. 6-8. Wm. H. Ross, secretary.

American Welding Society. Annual Fall Meeting, at Buffalo, N. Y., Nov. 16-19. Gideon W. Swan, general chairman, Morgan Bldg., Buffalo, First International Welding Exposition will be held in conjunction with meeting.

Chicago Power Show, at Chicago, Feb. 15-19. G. E. Pfisterer, managing director, 53 West Jackson Blvd., Chicago.

Engineering Institute of Canada. Annual meeting Jan. 18. Richard John Durley, secretary, 176 Mansfield St., Montreal, Que.

National Electric Light Association. A. Jackson Marshall, secretary, 29 West 39th St., New York City. Annual convention at Atlantic City, week beginning June 6.

National Exposition of Power and Mechanical Engineering. Fifth Annual Exposition at Grand Central Palace, New York City, Dec. 6-11.

National Marine Engineers' Beneficial Association. Fifty-third annual convention at Washington, D. C., Feb. 14. Albert L. Jones, secretary-treasurer.

Society of Naval Architects and Marine Engineers. Thirty-fourth annual meeting at Engineering Societies Bldg., 29 West 39th St., New York City, Nov. 11 and 12. T. J. Kain, assistant secretary-treasurer.

Flexible Couplings—The W. H. Nicholson & Co., manufacturers of machinery and steam specialites, Wilkes-Barre, Pa., have described in Bulletin No. 1026 the construction and functioning of the flexible coupling manufactured by them. It consists, as is explained, of two cast-steel hubs which are keyed to their respective shafts, and in which dovetail slots are cut to receive floating steel keys. The smaller couplings are equipped with three of these keys, and the larger sizes, five. Working parts of the coupling are inclosed in a cast-iron casing made in halves and bolted together with a gasket. This casing is firmly secured to one hub, and besides keeping dust and dirt out and oil in, it limits the lateral movement of the floatkeys in the slots. The parts are illustrated by eight figures. Dimensions, weights and price list are also given.

Distribution Transformers — Leaflet 20133-A has just been released by the Westinghouse Electric & Manufacturing Co. describing the Westinghouse type SK steel-clad distribution transformers. It describes in detail the outstanding features of the application and construction of this type of transformers, bringing out the new type of bushing that is being used. Halftone illustrations showing the transformers and the various parts complete this leaflet, which may be obtained at any of the district offices of the Westinghouse Co. or from the publicity department at East Pittsburgh, Pa.

Fuel Prices

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run except Pittsburgh gas slack:

Bituminous Net Tons	Market Quoting	Nov. 1 1926
Pool 1	New York	$4.50@$4.75
Smokeless	Boston	6.45
Clearfield	Boston	3.50@ 4.25
Somerset	Boston	3.75@ 4.50
Kanawha	Columbus	3.50@ 4.00
Hocking	Columbus	3.00@ 3.50
Pittsburgh	Pittsburgh	3.75@ 4.25
Pittsburgh gas slack	Pittsburgh	2.75@ 3.50
Franklin, Ill.	Chicago	2.35@ 2.50
Central, Ill.	Chicago	2.15@ 2.25
Ind. 4th Vein	Chicago	2.15@ 2.35
West Ky.	Louisville	1.20@ 1.60
S. E. Ky.	Louisville	3.00@ 4.50
Big Seam	Birmingham	1.75@ 2.00
Anthracite Gross Tons		
Buckwheat No. 1	New York	2.35@ 3.50
Buckwheat No. 1	Philadelphia	2.25@ 3.00
Birdseye	New York	1.35@ 2.00

FUEL OIL

New York—Nov. 4, light oil, tank-car lots; 28@34 deg. Baumé, 6c. per gal.; 36@40 deg., 6¾c. per gal. f.o.b. Bayonne, N. J.

St. Louis—Oct. 27, tank-car lots, f.o.b. St. Louis; 24@26 deg., $2.10 per bbl.; 26@28 deg., $2.15 per bbl.; 28@30 deg., $2.20 per bbl.; 30@32 deg., $2.25 per bbl.; 32@36 deg., gas oil, 6.026c. per gal.; 38@40 deg., 7¾c. per gal.

Pittsburgh—Nov. 2, f.o.b. local refinery; 30@34 deg., fuel oil, 6¼c. per gal.; 36@40 deg., fuel oil, 6¾c. per gal.

Philadelphia—Oct. 26, 27@30 deg., $2.52@$2.58 per bbl.; 13@19 deg., $1.59 @$1.65 per bbl.

Cincinnati — Nov. 2, tank-car lots f.o.b. local refinery, 24@26 deg. Baumé, 6¼c. per gal.; 26@30 deg., 6⅝c. per gal.; 30@32 deg., 7c. per gal.

Chicago—Oct. 18, tank-car lots f.o.b. Oklahoma, freight to Chicago, 92c. per bbl.; 24@26 deg., $1.35@$1.40 per bbl.; 26@30 deg., $1.50@$1.55; 30@32 deg., $1.75.

Boston—Nov. 1, tank-car lots f.o.b. 12@14 deg. Baumé, 4.9c. per gal.; 28@32 deg., 6c. per gal.

New Plant Construction

California—Vel Rose Ice Cream Co., 802 East Weber St., Lodi, plans the construction of ice manufacturing plants at Sacramento and Modesto. Estimated cost $40,000 each.

Calif., Colusa—Reclamation District 2070, is having plans prepared for the construction of a levee and drainage system including pumping plant, etc. Estimated cost $75,000. C. De St. Maurice, is engineer.

Calif., Hanford—Kings County, E. F. Pickerill, Clk, Hanford, will receive bids until Nov. 17 for the construction of a power house, heating plant, etc.

Calif., Long Beach—Long Beach Terminal Warehouse Co., awarded contract for the construction of a warehouse and cold storage plant, 4200 ton capacity at West Channel slip to Mathis Construction Co., 337 North Ave., Los Angeles.

Calif., Los Angeles—Two Thirty Three Club, Guaranty Bldg., Hollywood, plans the construction of a club building including steam heating system, elevators, swimming pool, etc. at Hollywood Blvd. and Vine St. Estimated cost $1,500,000. Walker & Eisen, Western Pacific Bldg., are architects.

Calif., Modesto—Modesto Irrigation Dist., C. S. Abbott, Secy., will receive bids until Nov. 22 for distribution transformers and electric meters. Estimated cost $30,000 and $10,000 respectively.

Calif., Sacramento — Syndicate, c/o Wright & Kimbrough, 817 Jay St., is having plans prepared for the construction of a 10 story medical arts building including central heating plant, ventilation system, elevators, etc. at 11th and L Sts. Estimated cost $1,000,000. Hyman & Appleton, 68 Post St., are architects.

Calif., San Bernardino—Mountain Water Ice Co., will build a 30 ton ice plant by day labor. Estimated cost $60,000.

D. C., Washington—Bureau of Yards & Docks, Navy Dept., will receive bids until Nov. 17 for engine driven generator in Naval hospital.

Ill., Chicago—Dearborn-Schiller Building Corp., A. J. Fitzgerald, Pres., 105 West Monroe St., awarded general contract for the construction of a 14 story apartment at Dearborn and Schiller Sts. to Fitzgerald Construction Co., 105 West Monroe St. Estimated cost $1,000,000. Bids later for steam heating system, central refrigeration plant, elevators, etc.

Ill., Chicago—Dept. of Public Works, A. A. Sprague, Comr., City Hall, will receive bids until Nov. 10 for furnishing and installing coal and ash handling machinery complete with all accessories in Western Ave. pumping station.

Ill., Danville—Interstate Water Co., H. G. Ely, Supt., awarded contract for the construction of a boiler plant to Clarke Construction Co. Estimated cost $50,000.

La., Franklin—City is having revised plans prepared for waterworks improvements including filtration plant, booster pumping station, pump, pumping equipment, 20,000,000 gal. reservoir, 500,000 gal. clear water reservoir, electric power transmission line, etc. Estimated cost $150,000. H. A. Mentz, Hammond, is engineer. Former bids rejected.

La., Goudsboro (mail McDonoghville)—Texas & Pacific Ry. Co., Dallas, Tex., awarded contract for the construction of shops, power plant, etc., to V. E. Ware Co., 1614 East Missouri St., El. Paso, Tex.

La., Shreveport — Shreveport Charity Hospital, c/o J. M. Mosely, Supt., will receive bids until Nov. 16, for the construction of a power house including low pressure boiler, etc. at Texas Ave. and Murphy St. Estimated cost $20,000.

Me., Farmington—Ted Toy-Lers Inc., 55 South Water St., New Bedford, Mass., awarded contract for the construction of a mill, boiler house, etc. on Main St. here, to J. W. Bishop Co., New Bedford, Mass.

Md., Baltimore—Mayor and City council, will receive bids until Nov. 17 for furnishing and installing pumping equipment in Hillen pumping station and Montebello filtration plant. V. B. Siems, City Hall, is engineer.

Mass., Boston — Edison Electric Illuminating Co., 70 State St., plans the construction of a power plant at Arch and Hawley Sts.

Mass., Holyoke—Germania Mills, Race St., awarded contract for the construction of a boiler house to Casper Ranger Construction Co., 20 Bond St. Estimated cost $40,000.

Mass., Mattapan (Boston P. O.)—Milton Ice Co., Milton, awarded contract for the construction of an ice making plant on Babson St. here, to W. G. Redd, 270 Blue Hill Pkway, Milton. Estimated cost $40,000.

Mass., Worcester—Municipal Water Dept. had plans prepared for waterworks improvements including new pump at Beaver Brook playgrounds, also repairing old equipment for pumping from Metropolitan reservoir. Estimated cost $70,000. Stone & Webster Inc., 147 Milk St., Boston, are engineers.

Mich., Detroit—Packard Motor Car Co., 1580 East Grand Blvd., is having plans prepared for the construction of a factory including power plant, boiler house, conveyors, hot water heating system, etc. Sessions Engineering Co., General Motors Bldg., Detroit, Mich., is engineer.

Mich., Camp Custer (Battle Creek P. O.) U. S. Veterans Bureau, Arlington Bldg., Washington, D. C., will receive bids until Nov. 30 for furnishing and installing a refrigeration plant in U. S. Veterans Hospital here.

Mich., Pontiac—Oakland Motor Car Co., Oakland Ave., is having plans prepared for the construction of a foundry, 300 ton daily capacity including steam heating system, electric motors, etc. Estimated cost $1,000,000. Private plans.

Minn., Minneapolis—Keith-Plaza Properties Inc., W. J. Keith, Trustee, plans the construction of a 12 story hotel at Hennepin Ave. and Kenwood Park. Estimated cost $1,000,000. Architect not selected.

Mo., Waldo—City Ice Co., 21st and Campbell Sts., Kansas City, is having plans prepared for the construction of an 80 ton ice plant here. Private plans. New equipment will be required.

Neb., Stamford—Village, R. E. Weare, Clk., will receive bids until Nov. 18, for waterworks improvements including 50 ft. tubular well, one 60 g.p.m. single stroke deep well pump, one 10 hp., 3 ph. 220 v. motor, etc. Henningson Engineering Co., National Bldg., Omaha, is engineer.

N. J., Jersey City—Christ Hospital, 176 Palisades Ave., plans the construction of a 4 story nurses' home, also extensions and improvements to power plant including two new 75 hp. boilers. Total estimated cost $300,000. J. T. Rowland, Jr., 100 Sip Ave., is architect.

N. Y., New York—Allerton Operating Corp., W. H. Silk, Pres., 285 Madison Ave., had plans prepared for the construction of an 18 story hotel including steam heating system, 8 electric elevators, etc. at 63rd St. and Lexington Ave. Estimated cost $4,000,000. Murgatroyd & Ogden, 285 Madison Ave., are architects. Jaros & Braum, 116 West 39th St., are engineers.

N. Y., Ossining—J. L. Long, Supt. of State Prisons, Capitol, Albany, will receive bids until Nov. 30, for refrigeration work, additional ammonia compressor and motor for Sing Sing prison, here.

O., Cincinnati—U. S. Engineer Office, 405 Custom House, will receive bids until Nov. 24, for one vertical, inverted cylinder compound engine and one 16 in. dredge pump and fittings for pipe line dredge "Indiana."

O., Columbus—Capitol University, Bd. of Trustees, O. Mees, Pres., East Main, St., awarded contract for the construction of a power house to E. H. Latham & Co., 447 Neilson St. Estimated cost $35,000.

O., Lancaster—Dept. of Public Welfare, J. E. Harper, Dir., Ninth and Oak Sts., Columbus, awarded contract for the construction of a powerhouse at Boys' Industrial School here to Henry & Burkey, Lancaster. Estimated cost $39,200.

O., Youngstown—The Vindicator Printing Co., W. F. Maag, Bus. Mgr., Phelps Boardman St., is having preliminary plans prepared for the construction of a newspaper plant including steam heating system etc. Estimated cost $500,000. Lockwood Greene & Co., Hanna Bldg., Cleveland, are architects and engineers.

Okla., Anadarko—City plans an election Nov. 23 to vote $40,000 bonds for the installation of a 500 hp. Diesel oil engine and generator in light plant. H. E. Musson & Co., Grain Exchange Bldg., Oklahoma City, are engineers.

Okla., Oklahoma City—New State Ice Co., 2 West 3rd St., awarded contract for converting present steam plant into raw water ice plant to Campbell & Price, 605 West Main St. Estimated cost $50,000. Motor driven equipment will be installed.

Pa., McDonald—McDonald Ice Co., will build an ice plant. Estimated cost $75,000. Frank Husband Co., 1427 Western Ave., Pittsburgh, is engineer. Work will be done by separate contracts.

Tex., El Dorado—City will receive bids after Jan. 1 for the construction of a waterworks and distribution system including pumping plant, etc. Estimated cost $60,000. Terrell Bartlett, Engrs., Calcasieu Bldg., San Antonio are engineers.

Tex., Galveston—Jean Laffite Hotel Co., c/o S. Moody, Pres., American National Insurance Bldg., will receive bids about Nov. 15 for the construction of a 10 story hotel at Ave. F. and 21st St. Estimated cost $500,000. A. Fraser, 824 American National Insurance Bldg., is architect.

Tex., San Antonio—A. Urrutia & Associates, Urrutia Hospital, has acquired a site and plans the construction of a sanatorium on Broadway Ave. Estimated cost $2,000,000 to $3,000,000.

Wis., Chippewa Falls — Clover Leaf Creamery Co., 417 Bridge St., is in the market for refrigeration machinery and equipment for creamery and ice cream factory.

Wis., Eau Claire—Tri-State Ice Cream Corp., Main and Frost Sts., La Crosse, is having plans prepared for the construction of an ice cream factory on Water St. here. Estimated cost $40,000. Refrigeration machinery will be required.

Wis., Madison—Oscar Mayer & Co., A. C. Bolz, Mgr., North St., awarded contract for the construction of a cold storage plant to M. M. Moen & Co., Mason City, Ia. Estimated cost $120,000.

Wis., Milwaukee—Holabird & Roche, 104 South Michigan Ave. Chicago, Ill., Archts., will soon receive bids for the construction of a 15 story hotel at Grand Ave., and 5th St. here for Schroeder Hotel Corp., 86 Michigan St., Milwaukee, Wis. Estimated cost $3,000,000.

Ont., Kapuskasing—Spruce Falls Pulp & Paper Co., 300 Bay St., Toronto, awarded contract for the construction of a dam, power house, etc. on the Mattagami River at Smoky Falls to develop 50,000 hp. and 80 mi. transmission line from Smoky Falls to Kapuskasing, also newsprint, sulphate and groundwood pulp mill here, to Morrow & Beatty, Ltd., 442½ George St., Petersborough. Estimated cost approximately $12,000,000. Owner is in the market for turbines, generators, switching, high and low tension power house equipment, motors, pumps, etc.

Ont., Ottawa—The Godson Building Co., 14 King St., Toronto, will soon receive bids for the construction of a 5 story apartment including electric refrigeration system, etc. on Lauerier Ave. E. here. Estimated cost $500,000 to $750,000.

Ont., Toronto — Crouse & Blackwell Canada Ltd., 43 Front St. E., has acquired a 3 acre site and plans the construction of a factory including steam boiler plant and heating system at Fleet and Bathurst Sts. Estimated cost $1,000,000. Engineer not selected.

Australia, Melbourne—Victorian Government Railways, will receive bids until Dec. 29, for two electric rivet heaters.

Mexico, Guadalajara—R. W. Morrison, 239 West Mistletoe Ave., San Antonio, Tex., has acquired the plants of the Compania Electrica Chapala and is having surveys made for extensions and improvements to increase the capacity from 30,000 to 40,000 hp., also approximately 80 mi. power transmission line from plant to Guanajuato Light & Power Co. Estimated cost $250,000 to $300,000 each. New turbines, generating units, etc. will be installed.

PRICES - MATERIALS - SUPPLIES

Electrical prices on following page are prices to the power plant by jobbers in the larger buying centers east of the Mississippi. Elsewhere the prices will be modified by increased freight charges and by local conditions.

SINCE LAST MONTH

PRICES of electrical supplies are steady; no changes of importance occurred during the month. In power plant supplies, linseed oil, silica brick, and the high grade babbitt metals, show gains compared with October. Colored cotton waste, magnesite brick, chrome brick, cement and crude ore declined. Clay brick, leather belting and lacing, portland cement, wiping cloths, red and white lead, pipe, rivets, boiler tubes and other steel products hold firmly to quoted levels.

POWER-PLANT SUPPLIES

HOSE—Quotations at New York warehouses:

	Fire Protection	50-Ft. Lengths
Underwriters' 2½-in., coupled, single jacket	(net) 74c. per ft.	
Common, 2½-in., cotton-rubber lined	80c. per ft. list less	40%

Air—Best grade

¾-in., per ft.	3-ply	$0.37½	4 ply	$0.46

Steam—Discounts from List

First grade	30-10%	Second grade	40%	Third grade	40-10%

RUBBER BELTING—List price 6-in., 6 ply, $1.83 per lin.ft. The following discounts from list apply to rubber transmission belting:

Best grade	50%	Second grade	50-10%

LEATHER BELTING—List price, 24c. per lin.ft. per inch of width for single ply at New York warehouses.

Grade	Discount from list
Medium	40-5%
Heavy	30-10%

RAWHIDE LACING—For cut, best grade, 50%, 2nd grade, 60%. For laces in sides, best, 41c. per sq.ft.; 2nd, 37c. Semi-tanned: cut, 50%; sides, 41c. per sq.ft.

PACKING—Prices per pound at New York warehouses:

Rubber and duck for low-pressure steam, ⅛ in.	$1.05
Asbestos for high-pressure steam, ⅛ in.	1.85
Duck and rubber for piston packing	1.05
Flax, regular	1.15
Flax, waterproofed	1.70
Compressed asbestos sheet	.95
Wire insertion asbestos sheet	1.40
Rubber sheet	.60
Rubber sheet, wire insertion	.85
Rubber sheet, duck insertion	.65
Rubber sheet, cloth insertion	.30
Asbestos packing, twisted or braided and graphited, for valve stems and stuffing boxes	1.40
Asbestos wick, ½- and 1-lb. balls	.50

PIPE AND BOILER COVERING—Discounts, New York warehouses, are as follows:

85% magnesia high pressure		50%
For low-pressure heating and return lines	4-ply	70%
	3-ply	72%
	2-ply	74%

PORTLAND CEMENT—New York, $2.50@$2.60 per bbl. without bags, in carload lots delivered on job. Bag charge of 40c. per bbl.

STRUCTURAL STEEL—New York delivered price, 3 to 15-in. beams and channels and 3 to 6-in. angles, tees, and plates, all $3.34 per 100 lb.

COTTON WASTE—The following prices are in cents per pound:

	New York	Cleveland	Chicago
White	13.00@17.50	18.00	15.00@20.00
Colored	10.00@14.00	13.50	12.00@17.00

WIPING CLOTHS—Prices per pound in lots of about 600 lb., for washed white wipers, as follows:

Chicago	$0.15
New York	.17½
Cleveland (*per thousand*)	36.00

LINSEED OIL—These prices are per gallon:

	New York	Cleveland	Chicago
Raw in barrels (5 bbl. lots)	$0.87	$0.98	$0.85

WHITE AND RED LEAD—Per 100-lb. keg, base price, f.o.b. New York:

	Dry		In Oil	
	Current	1 Yr. Ago	Current	1 Yr. Ago
Red	$15.25	$15.75	$16.75	$17.25
White	15.25	15.75	15.25	15.75

RIVETS—The following quotations are allowed for fair-sized orders from warehouse:

Rivets, ⅞x1-in. and longer, 19c. per lb., less 50% at New York warehouses Same discount for tinned. EXTRA per 100 lb. for 1½ to 2-in. long, all diameters, 25c.; ⅞-in. dia., 35c.; ¾-in., dia., 75c.; 1-in. long and shorter, 75c.; longer than 5-in., 50c.; less than 200 lb., 50c.; countersunk heads, 45c.

Structural rivets, per 100 lb.:

New York	$4.20	Chicago	$3.50	Pittsburgh	$2.50@2.60

Cone-head boiler rivets, per 100 lb.:

New York	$4.40	Chicago	$3.70	Pittsburgh	$2.90

REFRACTORIES—Prices in car lots f.o.b. plant:

Chrome brick, eastern shipping points	net ton	$45.00
Chrome cement, 40@ 50% Cr_2O_3, in bulk	net ton	22@25
Chrome cement, 40@ 50% Cr_2O_3, in sacks	net ton	26@29
Magnesite brick: 9-in. straights	net ton	65.00
Magnesite brick: 9-in. arches, wedges and keys	net ton	71.50
Magnesite brick: Soaps and spits	per ton	91.00
Silica brick: Mt. Union, Pa.	per M	43.00
Clay brick, 1st quality, 9 in. shapes, Pennsylvania	per M	40@45
Clay brick, 1st quality, 9 in. shapes, Ohio	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Kentucky	per M	40@43
Clay brick, 1st quality, 9 in. shapes, Maryland	per M	43@46
Clay brick, 2nd quality, 9 in. shapes, Pennsylvana	per M	33@38
Clay brick, 2nd quality, 9 in. shapes, Ohio	per M	38@40
Clay brick, 2nd quality, 9 in. shapes, Kentucky	per M	38@40
Clay brick, 2nd quality 9 in. shapes, Maryland	per M	38@40
Chrome ore crude, 40@50%	net ton	18.00@22.50

BABBITT METAL—Delivered, New York, cents per lb.:

Genuine, highest grade	89.00
Commercial genuine, intermediate grade	63.00
Anti-friction metal, general service	32.50
No. 4 babbitt (f.o.b.)	14.00

COLD DRAWN STEEL—Warehouse prices are as follows:

	New York	Cleveland	Chicago
Round shafting and screw stock, per 100 lb. base	$4.00	$3.90	$3.60
Flats and squares, per 100 lb. base	4.50	4.40	4.10

BOILER SPECIALTIES—F. o. b. New York or Jersey City, discounts on list:

	Current
Copper ferrules	70%
Boiler flanges	65-5%
Boiler stay bolts	60%
Boiler patch bolts	10%
Boiler fitting-up bolts	45%
Pressed steel boiler lugs	10%

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

BUTT WELD

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
1 to 3	62	50½	1 to 1½	30	12

LAP WELD

2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

BUTT WELD, EXTRA STRONG, PLAIN ENDS

1 to 1½	60	49½	1 to 1½	30	14
2 and 3	61	50½			

LAP WELD, EXTRA STRONG, PLAIN ENDS

2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

BOILER TUBES—Following are prices in New York warehouse of tubes manufactured according to specifications of the American Society of Mechanical Engineers:

Size	Lapweld Steel	C. C. Iron	Seamless Steel
1	.....	.....	$17 07
1¼	.....	.....	19 20
1½	.....	$38 00	17 92
1¾	.....	28 50	20 48
2	$17 33	25 00	20 24
2¼	19 84	28 25	23 00
2½	21 60	34 00	26 03
3	25.50	42 50	27 04
3½	30.25	49 50	30 67
3¾	31.50	52 75	33 33
4	38.03	67.00	40.11

Tubes 2½ in. diameter, or smaller, over 18 ft. long, 10 per cent extra.
These prices are net per 100 ft. based on stock lengths. If cut to special lengths, billing will be based on the entire stock lengths.
In addition to the above, standard cutting charges are as follows:
2 in. and smaller, 5c. per cut. 3 in., 9c. per cut
2¼ and 2½ in., 6c. per cut. 3½ to 4 in., 10c. per cut

ELECTRICAL SUPPLIES

ARMORED CABLE—Price per 1,000 ft.—5 per cent 10 days.

B. & S. Size	Two Cond. M Ft.	Three Cond. M Ft.	Two Cond. Lead M Ft.	Three Cond. Lead M Ft.
No. 14 solid	$32.50 (net)	$ 51.00 (net)	$164.00	$210.00
No. 12 solid	135.00	170.00	225.00	265.00
No. 10 solid	185.00	235.00	275.00	325.00
No. 8 stranded	285.00	375.00	520.00	500.00
No. 6 stranded	400.00	500.00	560.00	.....

From the above lists discounts are:		Lead Covered
Less than coil lots	50%	20%
Coils to 1,000 ft	60%	30%
1,000 to 5,000 ft	60–5%	35%
5,000 ft. and over	60–10%	38%

CONDUIT, Price per 1,000 ft.; **ELBOWS AND COUPLINGS**, Per 100 pieces, f.o.b. New York, with 10-day discount of 5 per cent.

Size In.	Conduit Black Per M	Conduit Galvanized Per M	Elbows Black Per C	Elbows Galvanized Per C	Couplings Black Per C	Couplings Galvanized Per C
¼	$56.50	$61.34	$7.76	$8.83	$4.52	$4.92
⅜	72.07	78.63	10.21	11.63	6.46	7.03
1	103.31	113.00	15.10	17.21	8.39	9.13
1¼	139.77	152.88	20.51	23.07	11.78	12.75
1½	167.12	182.79	27.34	30.76	14.56	15.75
2	224.85	245.94	50 13	56.40	19.41	21.01
2½	355.50	388.85	82.03	92 28	27.73	30.01
3	464.88	508 50	218.74	246 10	41.59	45.01
3½	585.30	637.74	483.04	543.46	55.46	60.02
4	714 17	776.30	558.23	628.06	69.32	75.02

CONDUIT BODIES AND FITTINGS—Black or galvanized.

	Less than $10 list	$10 list to $100	$100 list and over
Standard package	10%	20%	28%
Less than standard package	5%	10%	20%

CUT-OUTS—Following are net prices each in standard-package quantities:

CUT-OUTS, PLUG, SOLID NEUTRAL OR 2 FUSE

S. P. M. L.	$0.12	D. P. D. B.	$0.31
D. P. M. L.	.16	T. P. S. B.	.35
T. P. M. L.	.27	T. P. D. B.	.47
D. P. S. B.	.16		

CUT-OUTS, N. E. C. FUSE, SOLID NEUTRAL OR 2 FUSE

	0-30 Amp.	31-60 Amp.	60-100 Amp.
D. P. M. L.	$0.27	$0.70	$1.75
T. P. M. L.	.40	1.00	2.30
D. P. S. B.	.35	.87	.....
T. P. S. B.	.67	1.50	.....
D. P. D. B.	.65	1.75	.....
T. P. D. B.	1.12	3.00	.....
T. P. to D. P. D. B.	.75	2.10	.....

FLEXIBLE CORD—Price per 1,000 ft. in coils of 250 ft.:

No. 18 cotton reinforced heavy		$19.25
No. 16 cotton reinforced heavy		23.50
No. 18 cotton reinforced light		16.00
No. 16 cotton reinforced light		20.50
No. 18 cotton Canvasite cord		15.50
No. 16 cotton Canvasite cord		19.00
No. 16 super service cord or similar (2 wire) in	1,000 ft. $92.00	*101.20
No. 14 super service cord or similar (2 wire) in	1,000 ft. 133.00	*146.40

*Less than 1,000 ft.

NATIONAL ELECTRIC CODE FUSES, NON-REFILLABLE—

250-Volt	Std. Pkg.	List	600-Volt	Std. Pkg.	List
3-amp. to 30 amp.	100	$0.15	3-amp. to 30-amp.	100	$0.30
35-amp. to 60-amp.	100	.30	35-amp. to 60-amp.	100	.60
61-amp. to 100 amp.	50	.90	65-amp. to 100-amp.	50	1.50
101-amp. to 200-amp.	25	2.00	110-amp. to 200-amp.	25	2.50
201-amp. to 400-amp.	25	3.60	225-amp. to 400-amp.	25	5.50
401-amp. to 600-amp.	10	5.50	450-amp. to 600-amp.	10	8.00

Discount: Less 1-5th standard package, 60%; 1-5th to standard package, 64%; standard package, 68%.

RENEWABLE FUSES—List price each:

Sizes	250-Volt List-Price	600-Volt List-Price	Std. Pkg. Quantity	Carton Quantity
1 to 30-amp.	$0.50	$1.10	100	10
35 to 60-amp.	1.00	1.25	100	10
65 to 100-amp.	2.00	3.00	50	5
110 to 200-amp.	4.00	5.00	25	5
225 to 400-amp.	7.50	11.00	25	1
450 to 600-amp.	11.00	16.00	10	1

REFILLS—

1 to 30-amp.	$0.03 ea.	$0.05	100	100
35 to 60-amp.	.05 ea.	.06	100	100
65 to 100-amp.	.10 ea.	.10	50	50
110 to 200-amp.	.15 ea.	.15	25	50
225 to 400-amp.	.30 ea.	.30	25	25
450 to 600-amp.	.60 ea.	.60	10	10

Discount Without Contract—Fuses:	
Broken carton	5%
Unbroken carton but less than std. pkg.	22%
Std. pkg.	40%
Discount Without Contract—Renewals:	
Less than std. pkg.	Net list
Standard package	40%
Discount With Contract—Fuses:	
Broken cartons	10%
Unbroken cartons but less than standard package	26%
Standard package	42%
Discount With Contract—Renewals:	
Less standard package	Net list
Standard package	42%

FUSE PLUGS, MICA CAP—

0-30 ampere, standard package (500)	$2.75
0-30 ampere, less than standard package	3.00

LAMPS—Below are present quotations in less than standard package quantities on Mazda standard A type bulbs:

100—130 Volt Watts	Type	Price Each	200—260 Volt Watts	Type	Price Each
				Special	
15	A 17	$0.25	25	A 19	$0.30
	General		50	A 21	.30
25	A 19	.25	100	A 23	.53
40	A 21	.25			
50	A 21	.27			
60	A 21	.30			
100	A 23	.43			

Standard pkg. quantities are subject to discount of 10% from list. Annual contracts ranging from $75 to $300,000 net allow a discount of 15 to 40% from list.

PLUGS, ATTACHMENT—

	Each
Porcelain separable attachment plug	$0.18
Composition 2-piece attachment plug	.27
Swivel attachment plug	.12
Small size—2 Pc. Plug—Composition	.07

RUBBER-COVERED COPPER WIRE—Per 1000 ft. f. o. b. New York:

No.	Solid Single Braid	Solid Double Braid	Stranded, Double Braid	Duplex
14	$6 25	$9.75	$11.60	$18.20
12	10.10	12.60	14.60	23 80
10	13 20	16.40	18 60	30 50
8	19.00	22.30	24 20	42.40
6	.....	.....	34 40	....
4	.....	.....	48 00	.....
2	.....	.....	68 75	.....
1	.....	.....	94 70	.....
0	.....	.....	115 00	.....
00	.....	.....	138 00	.....
000	.....	.....	165 00	.....
0000	.....	.....	196 00	.....

SOCKETS, BRASS SHELL—Price each, net:

	½ In. or Pendant Cap Key	½ In. or Pendant Cap Keyless	½ In. or Pendant Cap Pull	¾ In. Cap Key	¾ In. Cap Keyless	¾ In. Cap Pull
Standard package.	$0.17	$0.15	$0.22	$0.20	$0.18	$0.25
Unbroken carton..	.18	.16	.23	.22	.19	.26
Broken carton....	.20	.18	.25	.24	.21	.28

WIRING SUPPLIES—

Friction tape, ¾ in., less 100 lb. 35c. lb., 100 lb. lots	33c. lb.
Rubber tape, ¾ in., less 100 lb. 37c. lb., 100 lb. lots	35c. lb.
Wire solder, less 100 lb. 29c. lb., 100 lb. lots	31c. lb.
Soldering paste, 2 oz. cans	$1.00 doz.

ENCLOSED SWITCHES, KNIFE—Safety type, externally operated, 250 d.c or a.c., N.E.C.

TYPE "C" FUSED BOTTOM

Size, Amp.	Double Pole, Each	Three Pole, Each	Four Pole Each
30	$4.50	$6.00	$7.25
60	7.50	8.25	10.50
100	10.50	13.00	22.50
200	16.00	20.00	36.00

Discounts:	
Less than $25.00 list value	30%
$25.00 to $50 0 list value	30–5%
$50.00 list value or over	35%